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REPORT ON INSPECTION OF COAL MINING OPERATIONS AND INCIDENTAL ACTIVITIES IN GREAT BRITAIN, FRANCE AND WEST GERMANY, AS RECOMMENDED BY THE ROYAL COMMISSION ON COAL (1959)

by

A. Brown*

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November 15, 1960

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*Head, Mining Research Section, Fuels and Mining Practice Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

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SUMMARY

On recommendation of the Royal Commission on Coal (1959), a mission of six Canadians visited the United Kingdom to inquire into mechanized coal-getting operations, and other matters related to coal mining, with the purpose of making available to the Dominion Coal Company of Sydney, Nova Scotia, information on current coal mining practices in the United Kingdom. Immediately following the visit to the United Kingdom, two of the mission examined mining operations in West Germany and France, as these countries were also included in the above recommendation.

As with most other industrial activities the mining industry is not static, and the development of new techniques and improvement of old practices is proceeding in all coal mining countries. In the result, a number of mining methods were observed during the course of these European inspections that warrant the careful consideration of the Dominion Coal Company and, indeed, of all other operators of underground collieries in Canada. For the reader's convenience these significant observations have been condensed into the form of recommendations, and are presented at the end of this report.

The body of the report contains details and analyses of the mining operations and equipment observed during the course of the visit. Attention has also been paid to labour-management relations, to the extent that this complex and imprecise subject could be studied in the space of a short visit.

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CONTENTS

	Page
Summary	1
Introduction	1
Developments in Power-Loading in Europe	4
Types of Mining Machines Employed	8
Productive Capacity of Mining Machines	10
Sizes of Coal Produced	25
Design of Power-Loaded Faces in Europe	30
Methods of Support	32
Coal Conveying Equipment	35
Operating Conditions and Practices in Collieries Visited	42
Manor Powis Colliery	42
Physical Conditions and Mining Practices	43
Bickershaw Colliery	45
Physical Conditions and Mining Practices	46
Moorgreen Colliery	48
Physical Conditions and Mining Practices	49
Rawdon Colliery	51
Physical Conditions and Mining Practices	52
Whitwell Colliery	54
Physical Conditions and Mining Practices	55
Maltby Colliery	57
Physical Conditions and Mining Practices	58
Ewald Fortszetzung Mine	60
Physical Conditions and Mining Practices	61
Rheinpreussen, Patteberg Schächte Colliery	64
Physical Conditions and Mining Practices	64
Mine No. 2, Oignies Group	67
Physical Conditions and Mining Practices	68
Mine No. 9, Hénin-Liétard Group	70
Physical Conditions and Mining Practices	71

(Continued ...

CONTENTS (Concluded)

Page

Activities Incidental to Coal Mining Operations 72

Discussions Regarding Bulk Sampling of Coal 72

Coal-Fired Electrical Generating Stations 73

Labour-Management Relations 76

Recommendations 78

—

TABLES

1. Types and Numbers of Machines in Use 9

2. Average Productions and Productivities of Major Machine Types 11

3. Productive Capacities of Machines Inspected 24

4. Percent Difference Between Hand-Loaded and Machine-Loaded Coal 28

5. Results of Tests with Mawco Machine at Whitwell Colliery 29

6. Results of Tests with Dranyam Machine at Donisthorpe Colliery 30

FIGURES

1. Dosco Miner 12

2. Dosco Miner at the Coal Face 12

3. Huwood Slicer-Loader 14

4. Huwood Slicer-Loader at the Coal Face 14

5. Anderson Boyes Trepanner 16

6. Anderson Boyes Trepanner at the Coal Face 16

7. Anderton Shearer-Loader 17

(Continued ..

FIGURES (Concluded)

		Page
8.	Anderton Shearer-Loader at the Coal Face	18
9.	The Meco Moore	19
10.	The Mawco Loader	20
11.	M & C Stripper	21
12.	Slow Plough	21
13.	Rapid Plough	22
14.	Gloster Getter Mark IV	22
15.	Flight Loader	23
16.	Huwood Loader	23
17.	Multi-Jib Loader	23
18.	Size Distribution for Principal Types of Power Loaders	26
19.	Dowty Hydraulic Prop	37
20.	Gerlach Prop	38
21.	Wanheim Prop with Roof Plate	38
22.	Desford Powered Chock	39
23.	Desford Hydraulic Chock	39
24.	Dobson "Double Two" Powered Chock	40
25.	Seaman Powered Chock	40
26.	Dowty Roofmaster Powered Chock	41
27.	Dowty Roofmasters on Coal Face	41
28.	Location of Power Stations Recently Completed or Under Construction - United Kingdom	74

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INTRODUCTION

The report of the Royal Commission on Coal (1959) included the recommendation that, without delay, a group of five persons, two representing the Dominion Coal Company, two representing the mine working force of that company, and an engineer representing the Dominion government, make an inspection of coal mining operations and incidental activities in Britain, France, Belgium, and West Germany, with the object of enabling the company to avail itself of the latest means of obtaining economic efficiency in its operation. In accordance with this recommendation, the above three organizations appointed representatives to the group, and arrangements were made with the National Coal Board of the United Kingdom for these representatives to visit a number of coal mining operations where the geological conditions were reasonably comparable with those of the Sydney coal field. Of special interest were the equipment used and the results being obtained with coal face mechanization. Arrangements were also made to visit several coal mining operations in continental Europe.

The appointed representatives included: F. Doxey, General Manager of Dominion Coal Company; G. Sigut, Mechanization Engineer, and G. Calder, Superintendent, of the same company; W. Marsh, President, and S. Dolhanty, Vice-President, of District 26, United Mine Workers of America; and A. Brown, Mining Engineer, Department of Mines and Technical Surveys, Ottawa.

The group of appointed representatives arrived in London on September 22 and a meeting was held on September 23 with W. V. Sheppard, Director General of Production, and J. W. Elliott, Deputy-Director

General of Reconstruction, both of the National Coal Board. During this initial meeting, the purpose of the mission was reviewed and the proposed itinerary of visits in the United Kingdom was discussed. This itinerary set up by the National Coal Board called for visits to four collieries, and a series of twelve meetings with management and union officials, between September 24 and September 30. These visits subsequently proceeded as planned, and the details of the operations observed are contained in a later part of this report. Following the completion of the initial itinerary of visits, two of the group, F. Doxey and A. Brown, remained in the United Kingdom to examine two types of mechanical mining machines not included in the original itinerary, and to visit the Central Engineering Establishment at Bretby. This latter establishment is an important centre for the engineering development and testing of mining equipment in the United Kingdom. Subsequently, also, Messrs. Doxey and Brown visited four coal mining operations in West Germany and northern France. The observations made during these later visits have also been included in this report.

During the course of these European inspections it was noted that, in some respects, the European mine operators have ideas to offer their Canadian counterparts that could help in obtaining economic efficiency of operations. These ideas on mining techniques have mainly to do with increasing the efficiency of the very important operations at the coal extraction face. Consequently, and in line with the recommendation of the Royal Commission on Coal to seek out means that could promote economic efficiency in the coal mines of the Dominion Coal Company, the bulk of this report has been devoted to reporting on these useful ideas.

In other respects, it was observed that certain European mining practices were about on a par with those being employed by the Dominion Coal Company, and that in some procedures the latter organization was obtaining a better performance. With respect to these practices, it is considered that no useful purpose would be served by reporting on them at length, but they will be briefly commented on here. As examples of the practices in which the Dominion Coal Company is on at least par basis with European operations, mention must be made of main coal haulage systems and mine ventilation. The better locomotive and rope haulage systems observed in Europe were about comparable with those employed in main tunnels and slopes by the Dominion Coal Company. It should be added that the practice observed in some European mines, of transporting the coal wholly by conveyor belts from production face to surface or main hoisting shaft, undoubtedly has many advantages, but the unusually long underground distances in the Sydney coal field makes an all-belt system impractical to consider, because of the prohibitively high capital cost. With regard to ventilation of mines, it was observed in Europe that practices quite similar to those of Dominion Coal Company were being employed. However, in a number of European collieries, it was noted that the temperatures at the working faces were noticeably higher than in the Cape Breton mines.

Throughout the stay in the United Kingdom and continental Europe, the Canadian delegation was courteously received and given full assistance in obtaining the required information. These courtesies were vital to the success of the mission and are sincerely appreciated.

DEVELOPMENTS IN POWER-LOADING IN EUROPE

An example of the increasing mechanization in the European coal fields is the remarkable development of mining machines in the United Kingdom since 1948, when less than three million tons of coal were mechanically-mined annually in that country. This development was especially rapid between 1954 and 1960, during which time the tonnage of mechanically-mined coal rose from eighteen million to over seventy million tons per year.

The large and rapid increase in mechanically-got coal has placed severe strains on older collieries that were designed to suit hand-filled operations at the production faces. A substantial change has also occurred in the size of coal produced, leading to increased marketing difficulties. Some of these problems have been reasonably well solved, but it is recognized that continuing study and development of new ideas are vitally necessary.

One of these problems arose because of the high coal-producing rate of the machines, which necessitated better coal conveying equipment on the production faces and in the roadways. A very workable solution to this problem has been the introduction of the flexible armoured conveyors on the faces, in conjunction with rubber conveyor belts in gate and trunk roads.

Another problem was the necessity of improving roof control, partly on account of the more rapid advance of the mechanized faces, but also because traditional methods had never been very satisfactory.

In this connection, there has been a widespread introduction of steel props, of both hydraulic and friction types. The substitution of steel props, for the wood supports previously used, has resulted in a very marked improvement in roof control on longwall faces. More recently, there has been a remarkable development in mechanized supports, which considerably reduces the manual effort required and promises much toward the elimination of the arduous and hazardous task of removing and re-setting roof supports by hand. In conjunction with the use of steel supports, both manually shifted and mechanized, there has been an increased use of total caving and consequently a reduction in the practice of partially packing the totally extracted areas behind longwall faces. Where applicable, total caving leads to substantial reductions in labour required and, frequently, to improved face conditions.

A significant development, also, has been the trend toward lengthening the extraction face in order to obtain larger tonnage and higher productivity from a single face. Consequently, wall lengths of six hundred feet or greater are quite common. It is also common practice to take two or more cuts off the coal face per day.

Other problems still await suitable solutions. These include those associated with stable hole preparation, gate road brushing, and the development of a mechanical mining machine capable of producing a large tonnage per shift and yet giving a product that in size consist is equal to or better than hand-got coal.

Regarding stable holes, there is one at each end of a mechanically-loaded longwall and they are, in reality, short lengths of the

coal face which are kept from five to ten feet ahead of the rest of the face. The length of coal face taken up by each stable is in the order of forty feet, and thus their combined lengths are but a fraction of the total wall length of, say, six hundred feet. The function of a stable hole is to give an edge, at right angles to the main coal face, from which a machine can begin removing a slice of coal off the wall face. It is comparable to beginning a saw cut at the end of a log. The problem in stable holes is that the tons of coal that must be removed during their construction are now being loaded by hand, for a suitable mining machine, capable of operating in such confined quarters, is difficult to design. The operation is therefore less productive and more costly than is desirable. In addition, the current slowness of this operation is a serious hindrance to hopes of significantly increasing the speed of wall advance, and thus, also, of making important increases in the tonnage of coal obtained from each longwall daily.

A second problem requiring solution is that of speeding up the brushing operation in the roadways leading to longwall faces. By brushing is meant the operation of enlarging the size of these roadways sufficiently to permit installation of coal conveying equipment and passage of men and material. In practice, this operation involves removing a thickness of the rock immediately overlying or underlying the seam, for the full width of the roadway. Commonly, the thickness amounts to four or five feet, and the width about fifteen feet. This rock is blasted down and the debris produced is stowed on either side of the roadway. To date, the operation is generally done by hand, with consequent higher costs and limited rate of advance. A beginning has been made toward mechanizing this operation through use of slusher stowers,

and by developing a rock shearing machine, but much remains to be done, before the latter is a practical unit, with regard to both its mechanical efficiency and suppression of the dust produced. It has already been indicated that the absence of suitable mechanism in the stable holes is a serious deterrent to any important increase in face production, and to this it can be added that the brushing operation is a production bottle-neck of equally serious proportions. It may be that the solution will best be found in the use of retreat longwalling.

The third main problem, referred to above, is that of developing a high-production mechanical mining machine that produces a suitably coarse size of coal. The history of mechanical mining in the United Kingdom shows that, as mechanization was progressively introduced, the proportion of small-size coal rapidly increased, leading to serious marketing difficulties in disposing of the small sizes. The most productive machines developed during the first years of mechanization were those that severely degrade the size of coal. The most outstanding example of this type of machine is the Anderton Shearer-Loader. In recent years there has been a drive to decrease the production of fine coal (-1/4" and -1/8" screen sizes) by restricting the use of machines that most degrade the coal, and by introducing types that produce coarser sizes. A considerable degree of success has been achieved in developing the newer type of machines. Typical of this class are the Mawco, Trepanner, and the Huwood Slicer-Loader. These are currently in different stages of development.

The principal types of mechanical mining machines employed in the United Kingdom are listed below, followed by discussions on their

productive capacities and the sizes of coal produced by each. This information is accompanied by illustrations of the principal machines. With regard to the machines employed in Germany, France, and Belgium, it should be repeated that they are, on the whole, quite similar to those used in the United Kingdom.

Types of Mining Machines Employed

The principal types of mechanical mining machines employed on longwalls in the United Kingdom are listed in Table 1, which shows the numbers of each type employed at year end of 1958, 1959, and July 1960.

Table 1 indicates that the number of power loaders is increasing by approximately 10 percent per year. It will also be observed that the growth is not uniform among the various types. Likely due to the drive for larger size coal, the use of the Anderton Shearer-Loader has been restricted and the number in use, although still by far the largest, has been almost stationary since 1958. Flight loaders and Meco Moores have been substantially reduced in numbers. The increases have been made in those types that produce larger-size coal, notably the Trepanner and the plough types. Included in the table are several newer types that, while still small in numbers, are showing good promise of giving a reasonably large productivity with improved coal sizes. These are the Huwood Slicer-Loader, the Mawco, the Dranyam, and the Trepan Shearer.

In order to study their capabilities and limitations, the machines will be individually considered according to their productive capacities, and the size of coal they produce.

TABLE 1

Types and Numbers of Machines in Use

Type of Machine	Number in Use			Change 1958-1960
	1958[x]	1959[x]	July, 1960	
Anderton Shearer-Loader	315	308	324	+ 9
Flight Loaders	167	148	130	- 37
Meco Moore	116	103	103	- 13
A. B. Trepanners	50	114	141	+ 91
Rapid Plough	46	66	108	+ 62
Multi-Jib Loaders	30	37	36	+ 6
Huwood Hydraulic	23	59	61	+ 38
Huwood Slicer-Loader	23	21	25	+ 2
Scraper Box Loader	15	20	25	+ 10
Gloster Getter	15	13	11	- 4
Slow Plough	9	6	5	- 4
Dosco Miner	7	9	8	+ 1
M & C Stripper	6	4	3	- 3
Huwood Mechanical	6	3	7	+ 1
Mavco Loader	1*	2*	7	+ 6
Dranyam Loader	0	1*	3	+ 3
Trepan Shearer	0	0	2	+ 2
Total (1)	829	914	999	+170

[x]At year end. *Prototype models.

(1) Exclusive of non power-loaded armoured conveyors and experimental machines.

Productive Capacity of Mining Machines

With regard to the productive capacity of each machine, an effort has been made to arrive at an average figure for the United Kingdom, in order to take the good with the bad. Nevertheless, it should be realized that mechanization is usually employed in coal fields that offer the best, or at least a reasonable,chance for its successful application. For this reason, nearly sixty percent of the mechanized output in the United Kingdom is mined in the East Midlands and the North Eastern Divisions, where the most regular seam conditions exist, and the balance is obtained from six other Divisions. The production capacities listed in Table 2 are therefore not indicative of what each machine can do in every seam of coal, but rather they represent what each can do in seams suitable for its use. It should also be cautioned that machines are not all equally versatile, and that some high-capacity machines have limited use because of their special seam requirements. With these qualifying remarks, the average productive capacities of the principal machines are listed in Table 2. These capacities are based on machine performances during the quarter year ending July 2, 1960, and are expressed in terms of tons of coal produced per 24 hours, and tons produced per machine shift. The third column in the table is the productivity figure, which is the number of tons produced per man shift employed on the longwall. The fourth column contains the weighted average seam thickness extracted by each type of machine. The machines are listed in order of tons produced per 24 hours. Following discussion of the national averages given in Table 2, the productive capacities of the machines actually observed during this visit are presented in Table 3. These are significantly different from the averages in Table 2.

TABLE 2

Average Productions and Productivities of Major Machine Types

Machine	Tons Produced*		Tons* Per Man-shift	Seam Thickness, Feet
	Per 24 hours	Per machine shift		
Dosco Miner	559	511	11.55	6' 3"
Huwood Slicer-Loader	531	299	8.48	5' 8"
A. B. Trepanner	511	282	8.96	3'10"
Anderton Shearer-Loader	444	269	7.88	4' 4"
Meco Moore	435	262	7.14	4' 9"
M & C Stripper	429	429	10.09	4' 5"
Mawco Loader	368	200	7.47	3' 5"
Trepan Shearer	330	217	7.88	3' 8"
Slow Plough	299	255	5.60	5' 4"
Rapid Plough	298	244	6.12	3'11"
Dranyam Loader	284	213	6.91	5' 5"
Gloster Getter	270	144	6.74	3' 9"
Flight Loader	189	167	5.08	3' 7"
Huwood Mechanical	185	164	6.55	2' 8"
Huwood Hydraulic	181	151	6.26	3' 9"
Multi-Jib Loader	102	83	4.31	2' 3"
Scraper Box Loader	96	85	3.90	3' 1"

*In 2000-pound tons of coal as mined.

It is apparent from Table 2 that the most productive machine, in seams suitable for its employment, is the Dosco Miner. This is particularly striking since, ordinarily, this machine can make only one

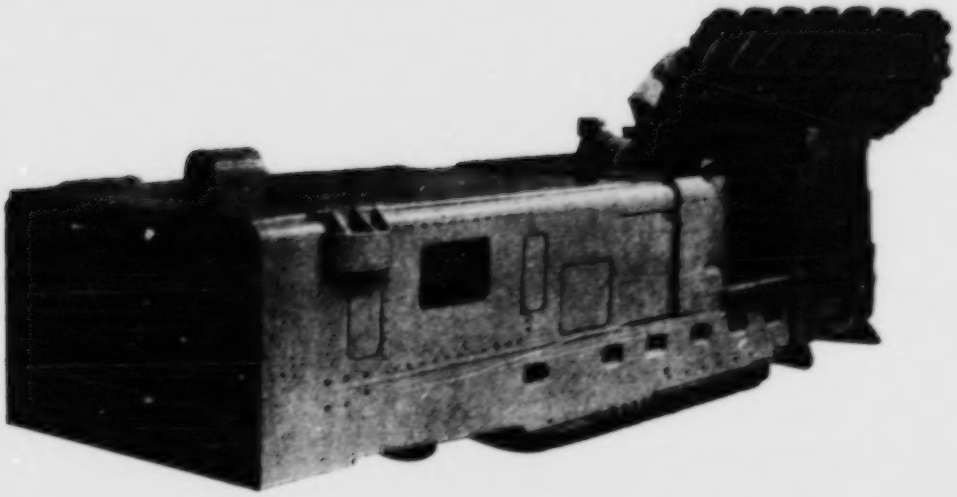


Figure 1. Dosco Miner

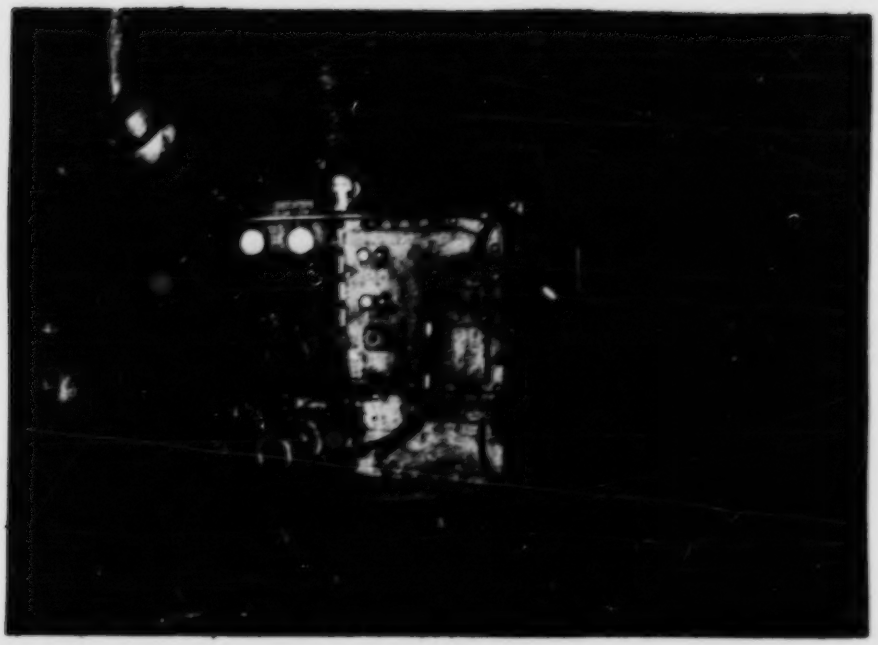


Figure 2. Dosco Miner at the Coal Face

cut per day. If the Dosco Miner could be readily turned around at the end of a machine shift, so as to enable it to take two cuts per twenty-four hours, its superior performance would be even more decidedly evident. Figures 1 and 2 are illustrations of the Dosco Miner. This 19-ton machine is caterpillar mounted, and extracts and loads in one operation a 5-foot-wide web of coal. In operation, the cutting jib is sumped into the bottom of the seam to a depth of about 18 inches and then raised vertically to extract the upper coal. An important advantage is that this machine can handle hard coals, and also that it can make its own roof by leaving several inches of coal to hold weak roof shales. The sizes of coal produced by this and other machines will be discussed later in this report. A limitation of the Dosco Miner, in its present design, is that it cannot be used in seams less than 5 feet high. Further to this, it should be added that the average coal height on longwalls in the United Kingdom is 4 feet 4 inches. This helps to explain why, despite its excellent performance, only eight of these machines are in use out of a total of approximately one thousand mechanical mining machines of various types. All the other machines listed in Table 2 are capable of working in seams 4 feet 4 inches high and, as may be noted, a substantial number of them are employed in seams between 2 and 3 feet thick.

Coming close to the Dosco Miner in daily output are the Huwood Slicer-Loader and the A. B. Trepanner. The Huwood Slicer-Loader, illustrated in Figures 3 and 4, is an adaptation of the coal plough that is now receiving considerable attention because of the large size coal it produces. This machine straddles the face conveyor, which guides it, and is pulled along the coal face with a chain. Double-ended, it cuts coal in both directions. The thickness of slice taken during each pass

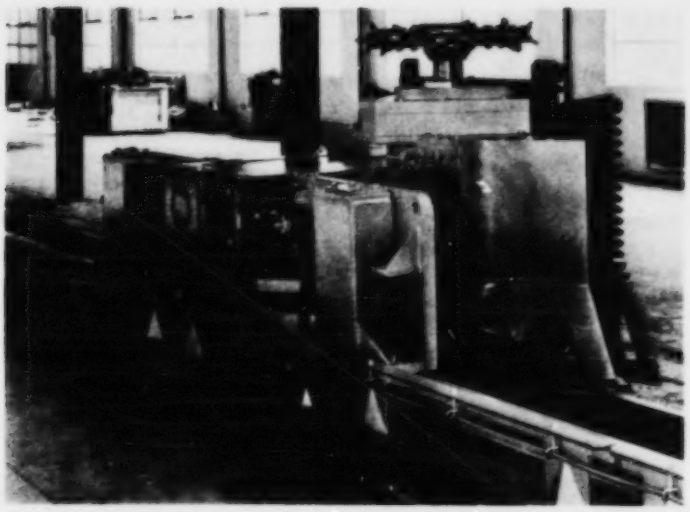


Figure 3. Huwood Slicer-Loader

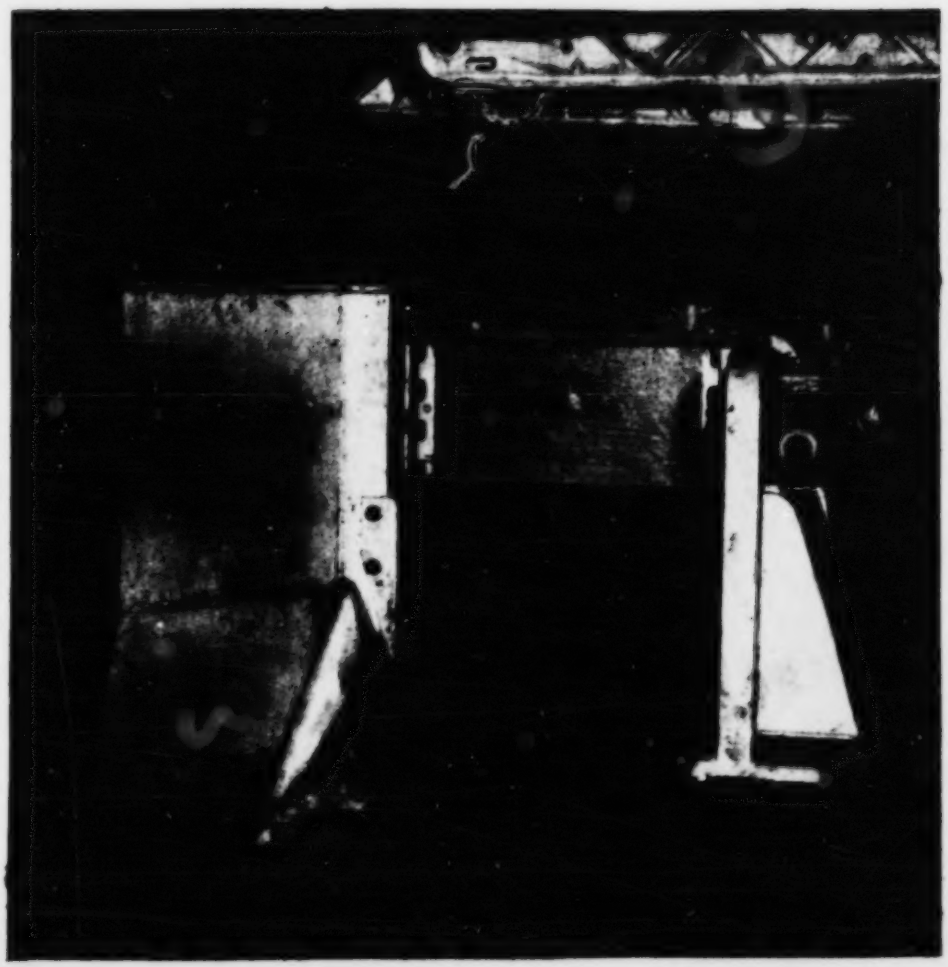


Figure 4. Huwood Slicer-Loader at the Coal Face

along the face is approximately 10 inches. The coal digging action is an eccentric chopping motion, with a stroke of 1/2 inch.

As with all coal ploughs, it is advantageous, when using this machine, to have a free parting between coal and rock, but because of its percussive action, and particularly when assisted by a pre-cut in the seam, its wider application to strong coal shows excellent promise.

The Anderson Boyes Trepanner, illustrated in Figures 5 and 6, is another machine developed because of the urgency of obtaining larger coal sizes. Already employed in substantial numbers, its use is rapidly expanding. This floor-mounted machine, weighing 8 tons, is double-ended and mines in two directions. It travels along the coal face by winching itself along a tautly-stretched chain or steel rope. In action, the revolving trepanner head, armed with cutter picks, cuts out a core of coal about 2-1/2 feet in diameter, and for the length of the longwall face. Subsidiary side and vertical cutting jibs are built into the machine to square up the roof and remove the arc-shaped fillets of coal left by the trepanner head.

The next most productive machine, the Anderton Shearer-Loader, is the one most widely in use. This machine, illustrated in Figures 7 and 8, is conveyor-mounted and, like the trepanner, travels by a winching action along a chain or rope. Basically, it is a longwall cutting machine, from which the jib has been removed and replaced with a cutting drum. In action, the revolving drum, armed with cutting picks, digs out a web of coal from 18 to 30 inches wide along the length of the coal face. The machine cuts in one direction, and ploughs spillage into the face conveyor during its return run. Drum diameters of up to 6 feet have been employed but over 85 percent are less than 4 feet.

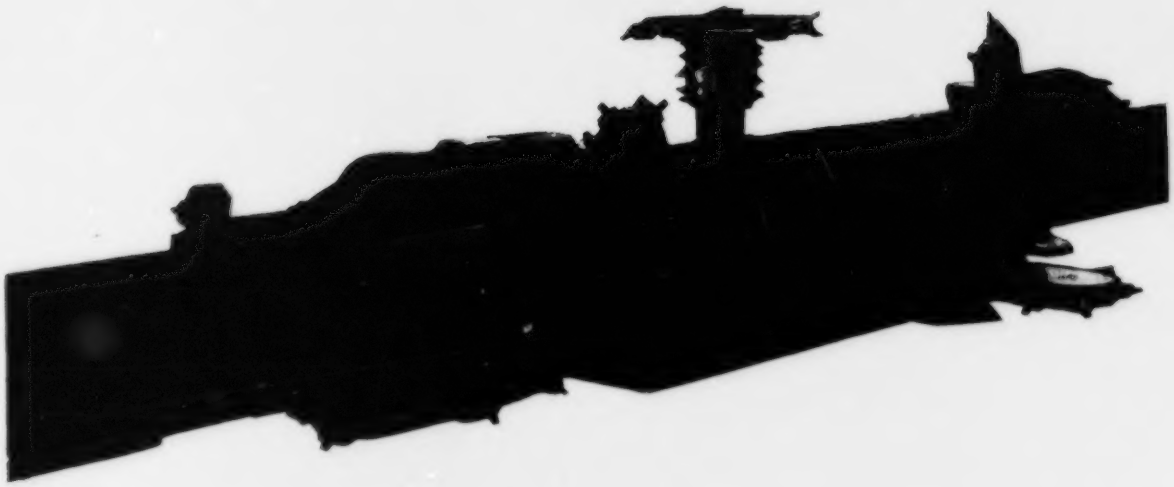


Figure 5. Anderson Boyes Trepanner

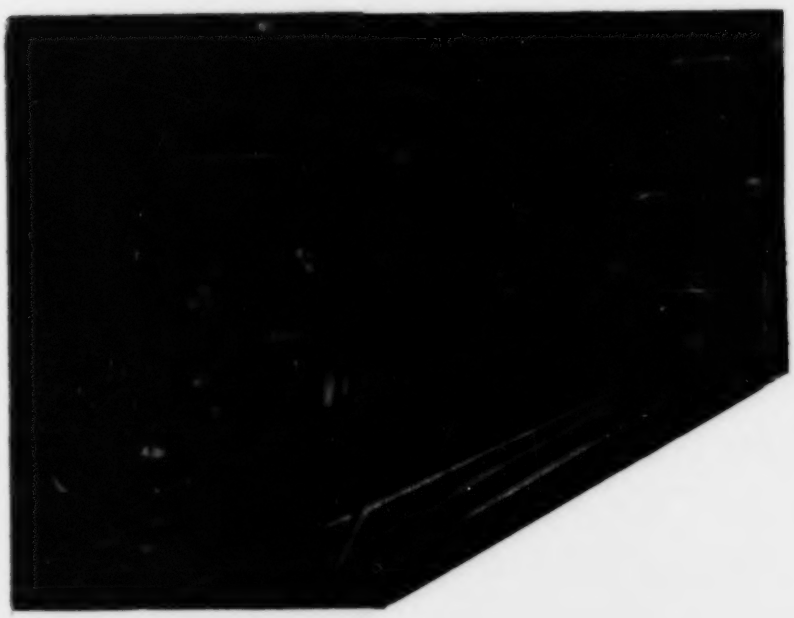


Figure 6. Anderson Boyes Trepanner at the Coal Face

Figure 7. Anderton Shearer-Loader

Figure 8. Anderton Shearer-Loader at the Coal Face

In numbers, the Anderton Shearer-Loader comprises one-third of all machines in use, and, in tonnage produced, it loads nearly forty percent of all coal mechanically mined in the United Kingdom. Unfortunately, the further application of this excellently designed machine has had to be restricted because of its excessive production of fine coal sizes. Recently, a combination Trepan-Shearer machine has been developed to improve product size.

Next in productive capacity is the Meco Moore. This was the first successful mechanical mining machine and, for many years, produced the bulk of the power-loaded coal in the United Kingdom. As illustrated in Figure 9, the machine has two horizontal cutting jibs and one triangular-shaped shearing jib. The coal removed from the seam is carried by a short conveyor to the main face conveyor. Although still a substantial producer of coal, it has been superseded to a considerable extent by the shearer and trepanner.

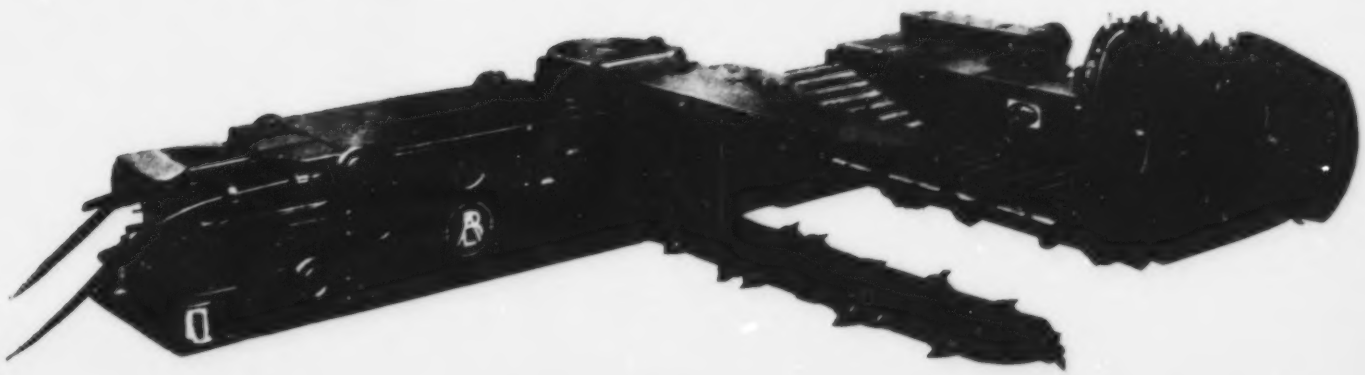


Figure 9. The Meco Moore

The remaining twelve machines listed in Table 2 include power loaders, such as the static blade ploughs, which are not considered to have useful application in the Sydney collieries, and others, such as the flight loaders, that have proved to be low-capacity machines. Some of these are illustrated in the accompanying illustrations, Figures 10 to 17. Among these, however, are two recently developed power loaders that are still few in numbers (see Table 1) but which may yet develop into major units. These are the Mawco Loader and the Dranyam Loader. Both were designed to improve the size consist of coal. The sizes of coal produced by these and others are described in the next part of this report, following Table 3.

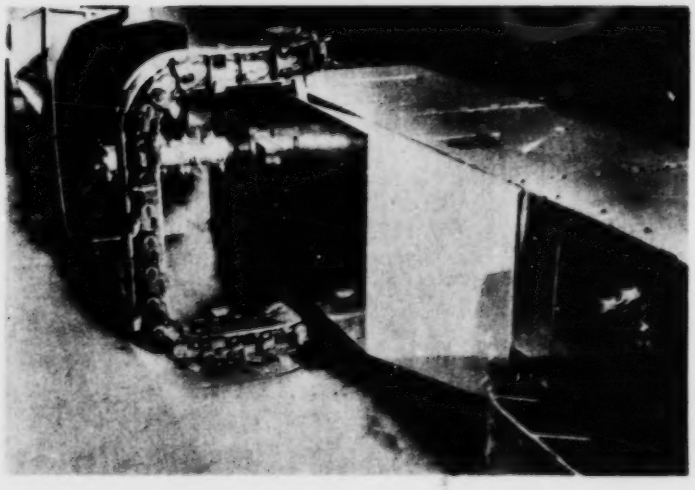


Figure 10. The Mawco Loader

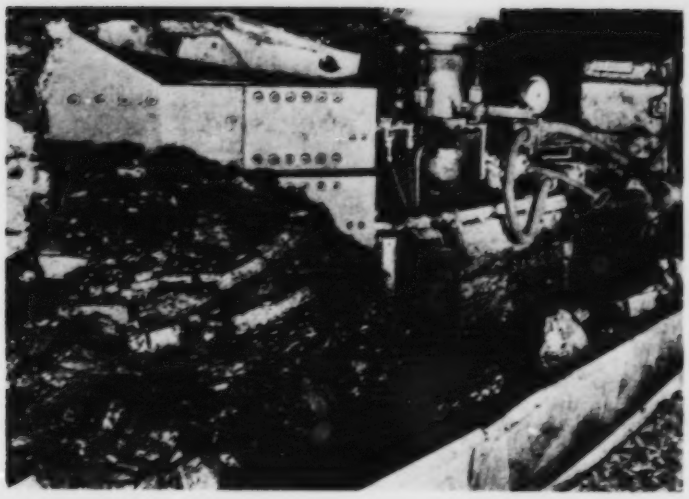


Figure 11. M & C Stripper

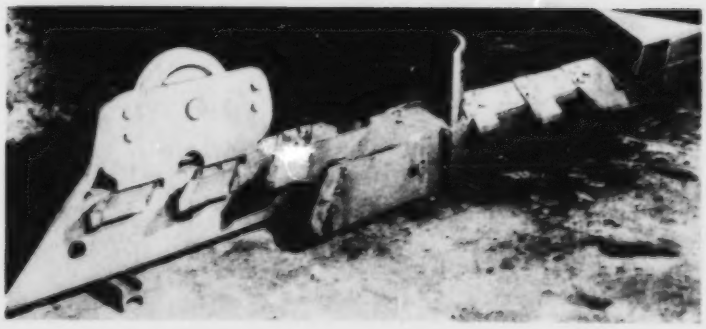


Figure 12. Slow Plough

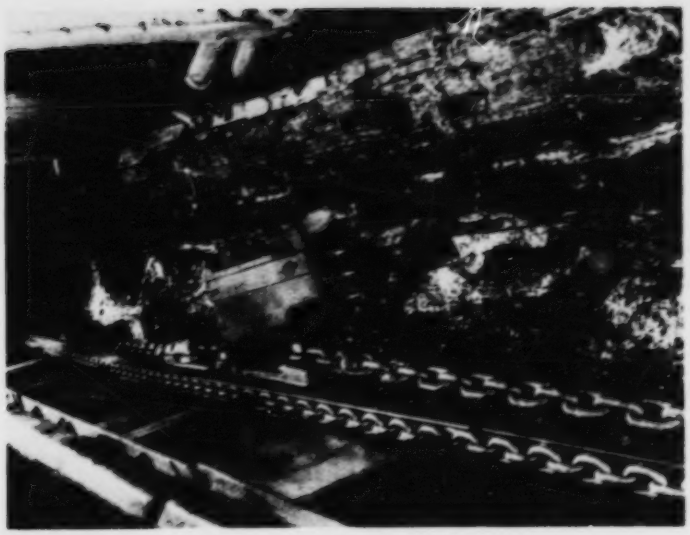


Figure 13. Rapid Plough

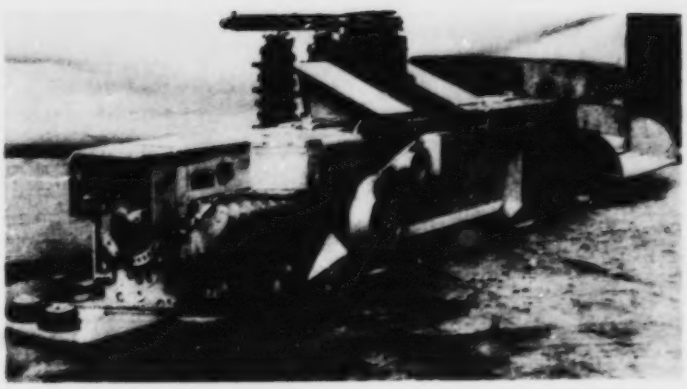


Figure 14. Gloster Getter Mark IV

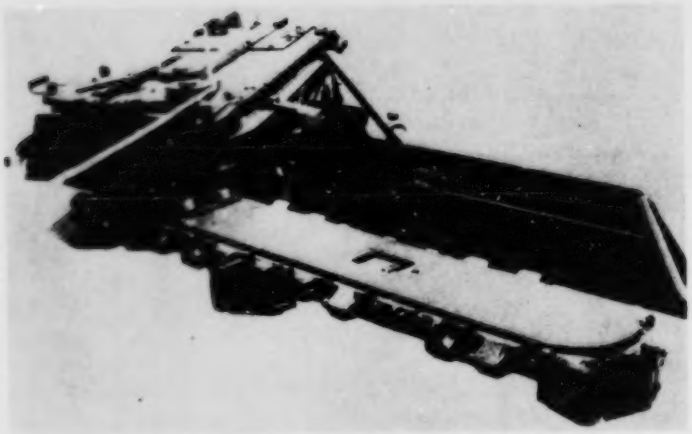


Figure 15. Flight Loader

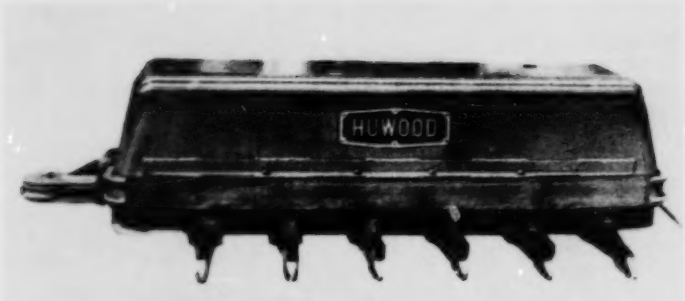


Figure 16. Huwood Loader

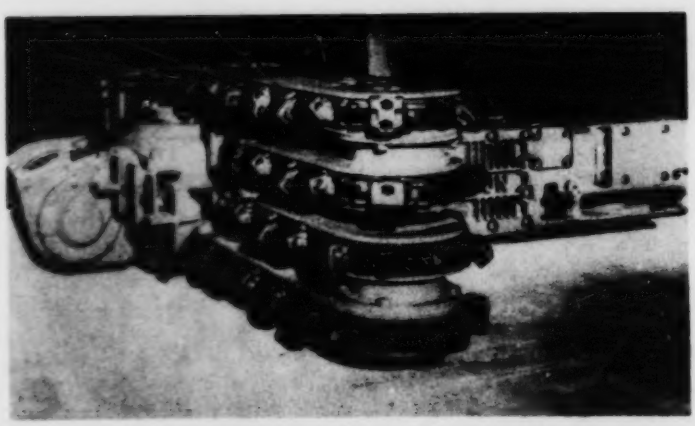


Figure 17. Multi-Jib Loader

TABLE 3

Productive Capacities of Machines Inspected

Machine	Mine	Output* per 24 Hours, tons	Loading Shifts per 24 Hours	Seam Thickness, feet
Anbauhobel Plough	Ewald Fortszetzung, Germany	1300	2	7
Shearer & Precutter	Bickershaw, U.K.	1200	2	5
Huwood Slicer-Loader	Maltby, U.K.	1040	2	6
Shearer	Manor Powis, U.K.	930	2	4½
Shearer	No.2, Oignies Group, France	880	2	5
Shearer	No.9, Hénin-Liétard Group, France	825	2	4½
Trepanner	Moorgreen, U.K.	770	2	4½
Dosco Miner	Rawdon, U.K.	680	1	6½
Mawco	Whitwell, U.K.	660	2	3

*All in short tons (2000 pounds) of untreated coal.

In discussion of Table 3 it should be added that the mines inspected were operating in flat-lying seams as compared with the moderately-pitching seams of the Sydney coal field. Otherwise, the geological conditions were reasonably comparable with those at Sydney. This table is important in showing the beneficial effects, on tonnage produced, of taking more than one cut per day off a longwall face. As will be noted, the Dosco Miner still produces most per shift, but other machines produce more per 24 hours. The ability to produce a high

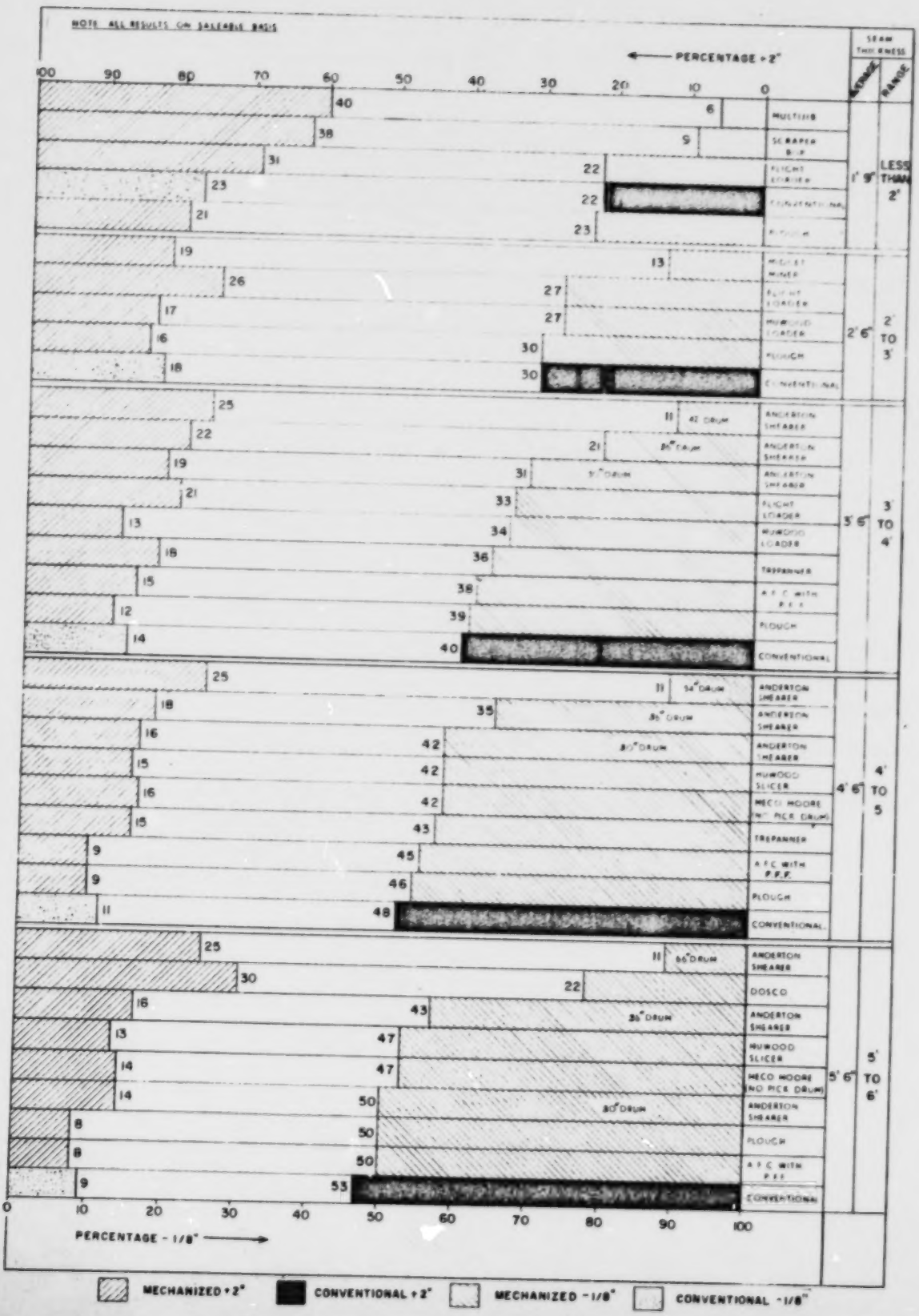
tonnage per 24 hours means that fewer longwall faces are required to furnish a colliery's output, resulting in a better concentration of operations with attendant savings in capital and operating costs.

The high productive capacity of the Anbauhobel Plough is an interesting example of what this simple, low-cost unit can do when conditions are suitable for its employment. It requires a soft coal, preferably with a low adhesion between the coal seam and the enclosing rock strata. These conditions do not exist in the Sydney coal field.

Sizes of Coal Produced

As indicated earlier in this report, the rapid increase in the use of mechanical mining machines was accompanied by a decrease in the amount of large coal and an increase in the small sizes. This led to difficult problems in disposing of the small coals, particularly those below 1/4 inch or 1/8 inch in screen size. The current problem in coal-producing countries, where mechanized mining has been introduced, is how to modify existing machines, or develop new types, so as to reduce the make of small-size coal. It is therefore important to consider, not only the productive capacity of various mechanical mining machines, but also the sizes of the coal produced.

Information on coal sizes produced by different machines is not always available, but on this visit some very useful data were furnished by the National Coal Board. These data were obtained from 230 individual sizing tests on the coal produced by several principal types of mining machines, and also by hand loading. This latter serves as a useful guide for judging the results obtained with the machines.


NOTE ALL RESULTS ON SALEABLE BASIS
PERCENTAGE + 2"
SEAM THICKNESS
RANGE
AVERAGE
100 90 80 70 60 50 40 30 20 10 0
40
38
31
23
21
19
26
17
16
18
6
9
22
22
23
13
27
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8
9
11
22
43
47
47
50
50
50
53
1' 9"
2' 6"
3' 6"
4' 6"
5' 6"
LESS THAN 2'
2' TO 3'
3' TO 4'
4' TO 5'
5' TO 6'
MULTIBIT
SCRAPER
FLIGHT LOADER
CONVENTIONAL
PLOUGH
MULTIBIT MINER
FLIGHT LOADER
HUMBOLD LOADER
PLOUGH
CONVENTIONAL
ANDERTON SHEARER
ANDERTON SHEARER
ANDERTON SHEARER
FLIGHT LOADER
HUMBOLD LOADER
TREPANNER
A.F.C. WITH P.F.P.
PLOUGH
CONVENTIONAL
ANDERTON SHEARER
ANDERTON SHEARER
ANDERTON SHEARER
HUMBOLD SLICER
MECO MOORE (W. PICK DRUM)
TREPANNER
A.F.C. WITH P.F.P.
PLOUGH
CONVENTIONAL
ANDERTON SHEARER
DOSCO
ANDERTON SHEARER
HUMBOLD SLICER
MECO MOORE (NO PICK DRUM)
ANDERTON SHEARER
PLOUGH
A.F.C. WITH P.F.P.
CONVENTIONAL
42" DRUM
84" DRUM
91" DRUM
54" DRUM
86" DRUM
80" DRUM
66" DRUM
86" DRUM
80" DRUM
0 10 20 30 40 50 60 70 80 90 100
PERCENTAGE - 1/8"
MECHANIZED + 2"
CONVENTIONAL + 2"
MECHANIZED - 1/8"
CONVENTIONAL - 1/8"

This information is contained in Figure 18. As may be noted, the information is presented for five ranges of coal heights between 2 feet and 6 feet. Although the results are based on 230 tests in various coal seams, it must be cautioned that they give only an approximate idea of what each machine would do if employed in other seams. Factors such as strength of coal, height of seam, partings, cleavage, and stone inclusions, all influence the size of coal obtained. It will also be noted, in Figure 18, that the coal has been divided into three screen sizes, namely: -1/8 inch, +1/8 inch - 2 inches, and +2 inch size. The -1/8 inch is the most difficult size to market, except to special customers such as pulverized fuel users, and, as a general rule, there is an urgency to reduce the production of this size to a minimum.

Because the heights of the seams currently being mined in the Sydney coal field lie in the range of four to six feet, special attention should be paid to the results obtained for the corresponding seam thicknesses in Figure 18. It is useful, for instance, to determine how the size of coal changes when power loading is substituted for hand loading. As may be expected, the general tendency whenever power loading is introduced is for the percentage of plus 2 inch size to decrease, but it is important to know whether this decrease results in an increase in the saleable middle sizes (+1/8" - 2"), or if the result is mainly an increase in the percent of fine coal. Table 4 has been prepared from the data contained in Figure 18, to show the difference between hand-loaded and machine-loaded coal in two seam heights. For each machine, the differences are shown as percentage differences with respect to hand-loaded coal. As an example, the shearer with a 30-inch drum, operating in a 4 to 5 foot seam, produced 6 percent less coal of

+2 inch size than did hand-loading, and this decrease in the amount of +2 inch size coal was accompanied by an increase of 1 percent in the middle sizes (+1/8" - 2") and an increase of 5 percent in the fine sizes (-1/8"). The data for the other machines can be similarly interpreted.

TABLE 4

Percent Difference Between Hand-Loaded and Machine-Loaded Coal

Screen Sizes	Difference in 4-5 Ft Seams			Difference in 5-6 Ft Seams		
	-1/8"	+1/8"-2"	+2"	-1/8"	+1/8"-2"	+2"
For Hand Loading	0	0	0	0	0	0
For Shearer 30" Drum	+ 5%	+ 1%	- 6%	+ 5%	- 2%	- 3%
For Shearer 36" Drum	+ 7%	+ 6%	-13%	+ 7%	+ 3%	-10%
For Shearer 54" Drum	+14%	+23%	-37%		No Data	
For Shearer 66" Drum		No Data		+16%	+26%	-42%
For Dosco Miner		No Data		+21%	+10%	-31%
For Huwood Slicer	+ 4%	+ 2%	- 6%	+ 4%	+ 2%	- 6%
For Meco Moore	+ 5%	+ 1%	- 6%	+ 5%	+ 1%	- 6%
For Trepanner	+ 4%	+ 1%	- 5%		No Data	
For Plough	- 2%	+ 4%	- 2%	- 1%	+ 4%	- 3%

An examination of Table 4 indicates that the machines which least degrade the coal are, in order, the Plough, Huwood Slicer, Trepanner, Shearer (30" Drum), and the Meco Moore. A machine that combines this ability to deliver an acceptable product size with a satisfactorily high loading capacity would be a useful machine where fine size coal

creates a marketing problem. Reference to the productive capacities in Table 2 suggests that the Huwood Slicer and the Trepanner could best suit these two requirements. To this it should be added that the Dosco Miner observed at Rawdon Colliery was producing 31 percent of +2 inch coal size, which is a considerable improvement over the 22 percent shown in Figure 18. At Rawdon, the face was being pre-cut at mid-seam height and this pre-cutting undoubtedly was the reason for the higher percentage of coarse coal.

It will be noted in Figure 18, and consequently in Table 4, that no information is given on the size of coal produced by two of the more recently developed machines, namely the Mawco and the Dranyam. Tables 5 and 6 are presented below to show the results of testing carried out at Whitwell Colliery with the Mawco Cutter-Loader, and at Donisthorpe Colliery with the Dranyam. In each table, the sizes of coal obtained with each machine are compared with those obtained, in the same seam, with other loading methods.

TABLE 5

Results of Tests with Mawco Machine at Whitwell Colliery

Size Fraction	Weight, % Run - of - Mine			
	Mawco Cutter Loader		Anderton Shearer	Hand Loaded
	40" x 23" Frame	43" x 27" Frame		
+ 2"	41.5	52.5	7.4	57.4
-2" + 1/8"	39.8	35.4	69.1	36.1
- 1/8"	18.7	12.1	23.5	6.5

The High Hazel seam, at Whitwell Colliery, is approximately 3 feet high, and the coal is of moderate hardness with a well-defined cleat. The length of coal face was 579 feet, and the coal produced per shift was around 350 tons. As will be noted in Table 5, the product size is much better than that for the shearer, and compares reasonably well with hand loading. No breaker bar was employed on the Mawco in these tests. The Mawco cutter chain needs further improvement, as its long length leads to high cutting loads, and its rectangular jib should be made collapsible to allow for convergence along the face.

TABLE 6

Results of Tests with Dranyam Machine at Donisthorpe Colliery

Size Fraction	Weight, % Run - of - Mine		
	Dranyam Drum leading	Dranyam Drum trailing	Anderton Shearer
+ 2"	20.1	14.7	1.9
-2" + 1/8"	60.6	64.7	67.4
- 1/8"	19.3	20.6	30.7

The results of this limited test indicate that, when used in the same seam, the Dranyam Shearer produces a larger size coal than the standard type shearer.

DESIGN OF POWER-LOADED FACES IN EUROPE

In general, the longwall faces observed in Europe were situated in seams of lower inclination, and in strata that were much more geologically disturbed, than those of the Sydney coal field. The depths of the various mines visited were, as a rule, considerably less than those of

the main Cape Breton collieries. The majority of the seams examined were between three and four and one-half feet thick, but two operations were visited, one in the United Kingdom and one in West Germany, where seam heights were six feet and seven feet, respectively. Details of these and other visits are contained in a later part of this report.

The longwalls visited in Europe were single unit faces and, contrary to Cape Breton practice, it appeared that the use of several faces in line was not common, particularly where mechanical mining machines were employed. Despite the loss of a substantial tonnage of coal in the pillars left between successive wall faces, it was considered that recompensing benefits were obtained through the better condition and lower direct cost of gateroads, and the fact that the working of one wall was independent of delays that might occur on a neighbouring face. An additional advantage of single faces is the relative ease with which a longwall panel can be sealed off in case of an underground fire. Essentially, however, the question of single faces and hence partial extraction of mineral resolves itself into one of whether it is the duty of the present generation fully to extract a natural resource at all times, or whether it is sometimes more commendable to leave a percentage unworked, with the object of lowering current production costs and improving the competitive position of the mineral in today's markets. Specifically, in the case of the Sydney submarine mines, the latter course is worth serious consideration provided adequate precautions are taken to limit the amount of coal thus abandoned.

In general configuration, the individual longwall extraction faces in Europe resemble those of Canada. Most are advancing longwalls,

with servicing roadways constructed and maintained in the wastes. A notable difference is in the lengths of the mechanized faces, for these tend to be longer than those in the Sydney coal field, where face lengths of 400 and 500 feet are employed. In Europe, the average length is about 600 feet, and lengths to 1000 feet are fairly common. The object is to increase the tonnage of coal obtained per foot of face advance, and thus compensate, in part, for the delays associated with stable hole construction and level brushing. More continuous operation of mining machines is also achieved on longer faces.

METHODS OF SUPPORT

The use of wood supports on longwall faces is being rapidly superseded by metal supports, and this change has resulted in a very marked improvement in roof control and working conditions along the extraction faces. Both friction-type and hydraulic-type props are in common use but, in general, it can be said that the hydraulically-operated units are favoured in the United Kingdom, whereas the friction type are the kind most employed on the Continent. Excellent results are being obtained with each type but they have significant points of difference with respect to each other. The friction-type prop has a lower first cost, is simpler in design, and can be more readily repaired underground. The hydraulic type is designed to give a more uniform yield under load and is more easily installed by a single person. It is, however, subject to failure in its hydraulic mechanism, and structural deformation is hard to repair. Nevertheless, it appears to have the brighter future of the two because its hydraulic functioning lends itself to easier manipulation, as already evidenced by the growing use of hydraulic-powered supports, and because it offers a practical avenue of

approach to the remote control of face supports.

Initially, when steel face supports were being introduced on longwall faces, their sole function was to replace a variably-yielding wood support with a metallic prop of higher load-bearing capacity and whose yield under load could be reasonably well predicted. These metal props could be used with good effect on hand-loaded as well as on machine-loaded wall faces. Props developed for this purpose include the Dowty, Dobson, Polar, Wanheim, of the hydraulic type, and the Schwarz, Gerlach, Huwood TCR, Uerdinger, etc., of the friction type.

With the further advance in mechanical loading systems, the steel face supports were called upon to perform additional functions, including the pushing over of the armoured flexible face conveyor, and inducing the roof to break in total caving methods. Developments were also carried forward to make the supports self-advancing. The steps taken to incorporate these additional functions into the face support system have resulted in the development of hydraulic-powered (self-advancing) supports. Typical of these are the Dowty Roofmaster, Seaman Hydraulic Chock, Dobson "Double Two", Desford Chock, Hudswell Clarke, and the French-developed SAHE powered chock. The German firm, Rheinstahl Wanheim, of Duisburg, is currently developing a hydraulic-powered support.

It is obvious that that whole field of face support systems is being energetically reviewed and it is a generally held opinion that, in the wake of the large advances made during the past ten years in power-loading machinery, the next important advances in coal mining will be in face support systems. Advances in these systems, particularly those leading to their fullest mechanization, are vitally necessary.

The face supports must be capable of keeping up with even faster rates of face advance, and should not be allowed to become a production bottle-neck as is the current situation with stable hole and face brushing operations. Advances in face support mechanization are also required, to reduce the labour involved in removing and resetting individual props. With faster rates of face advances, and the greater rapidity of prop resettings per shift, hand labour becomes more and more unrealistic. There appears to be a good possibility of remotely controlling the movement of hydraulic-powered supports from the gateroad. Significant advances along these lines have been made in the Mining Research Establishment of the National Coal Board, and early field trials are scheduled.

Illustrations of a number of principal types of roof supports are given in Figures 19 to 27.

A discussion on metal supports would not be complete without giving some information on the losses being sustained in their numbers, and an idea of their maintenance cost. In the Iron and Coal Trades Review of October 7, 1960, it was reported, for Number 4 Area of the East Midlands Division, that out of a total number of 59,539 hydraulic props in use at the beginning of 1959, 14,296 were lost during that year. The cost of these missing props was approximately £184,000. The number serviced in the shops during 1959 was reported to be 27,337, and the average cost of repairing these props was given as 28 shillings 5 pence each. This last figure included all labour, materials, and fixed charges. The wastage (loss) of link bars in 1959 amounted to 13,380 bars with a value of £ 83,625. Altogether, the cost of replacing losses of props and bars, plus repairs to serviced units, handling, etc., amounted to

£ 350,000 in Number 4 Area during 1959, which was approximately 1 shilling 4.3 pence per ton of mechanically loaded output. This record for Number 4 Area is presented here to emphasize the necessity for careful control of expensive equipment to reduce outright losses and excessive damage.

COAL CONVEYING EQUIPMENT

In all mines visited, the type of face conveyor was similar to that employed on the longwall faces in the Sydney coal field. This type is the flexible armoured conveyor, originally developed in Germany but since adopted and improved upon by other countries. It is a rugged, scraper-chain type of conveyor, capable of transporting the coal from high-capacity mining machines and, as indicated earlier in this report, it can also serve as a travelling track and guide for heavy, conveyor-mounted mining machines. Its flexible construction allows it to follow irregular extraction faces, or to be flexed (shoved) to the coal face close behind a mining machine.

Transport of coal on roadways in all mines visited was by rubber conveyor belts. These belts generally extended for substantial distances to mine car loading points and, at times, all the way to the hoisting shaft or surface. This use of long conveyor belts is an important means of insuring a continuous flow of coal from the production faces, thus enabling the mining machines to operate with fewer interruptions and at maximum capacity. In the Sydney field, conveyor belts have been employed for many years, and the current general practice is to use fixed length units of 500 feet or less, which are advanced daily. It is considered that the European practice of employing long belt lines,

leading to main car-loading points underground, could be adopted with advantage in the Sydney field. It should be mentioned that a start has been made in this direction at Sydney in the case of two experimental retreat longwalls. It is not suggested that conveyor belts should be used to convey coal all the way to surface in the Sydney mines, for the underground distances are large, and the capital cost of the belt lines would be prohibitive. Fortunately it is not necessary to consider all-belt transport at Sydney, for the main haulage systems in the submarine mines are quite efficient, these including the trolley and diesel locomotives on level hauls, and the balanced hoisting on main slopes. What is envisaged, is the establishment of main car-loading points underground to which the coal from one or more longwall faces would be delivered by gathering and trunk conveyors. Even with this more limited use of belts the capital cost would be large, and conceivably beyond the means of an individual company to finance.

Any decision to proceed along these recommended lines should be regarded as commendable, but the cost and function of each installation should be carefully considered.

Figure 19. Dowty Hydraulic Prop

Figure 20. Gerlach Prop

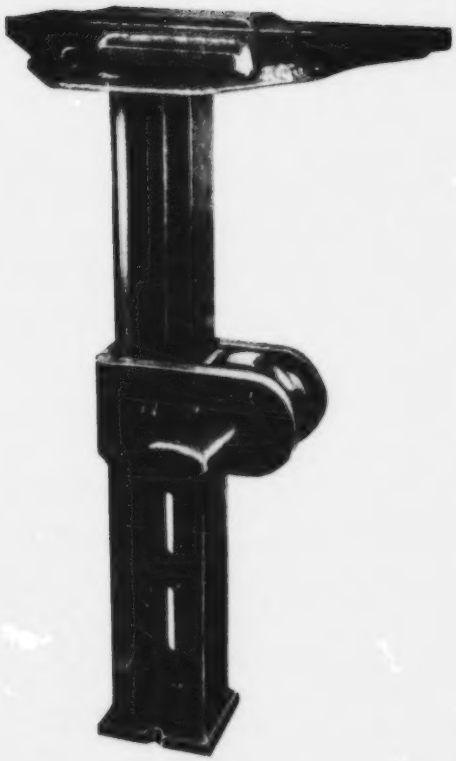

Figure 21. Wanheim Prop with Roof Plate

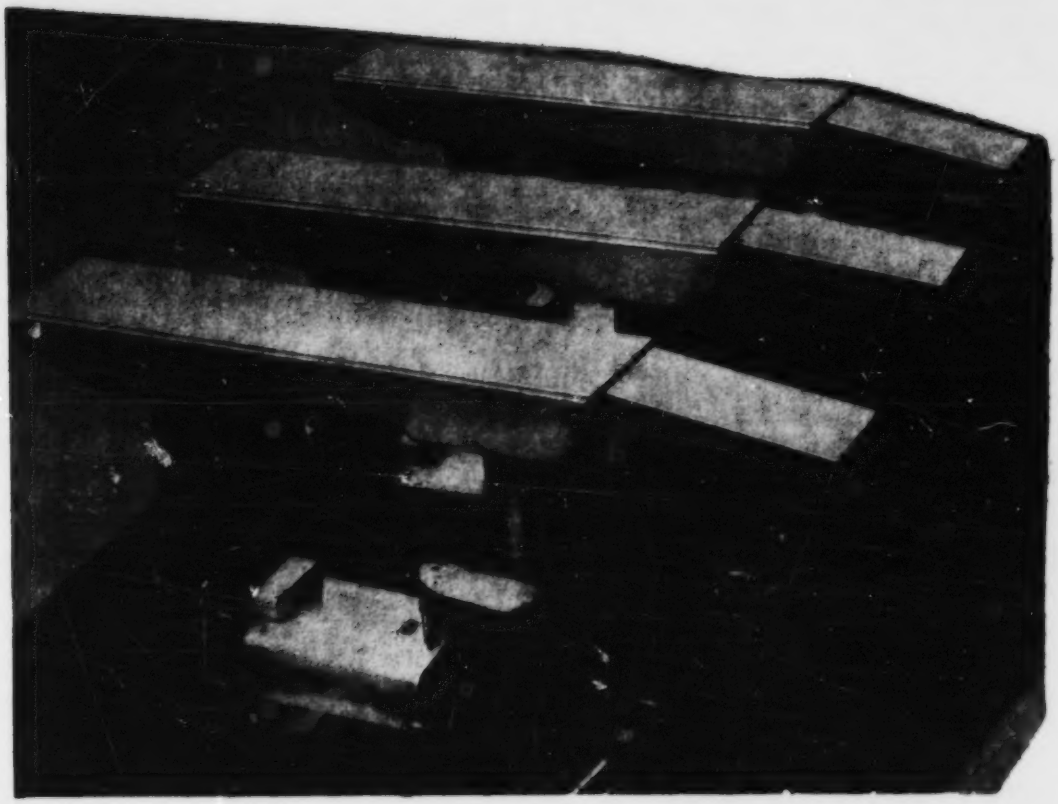

Figure 22. Desford Powered Chock

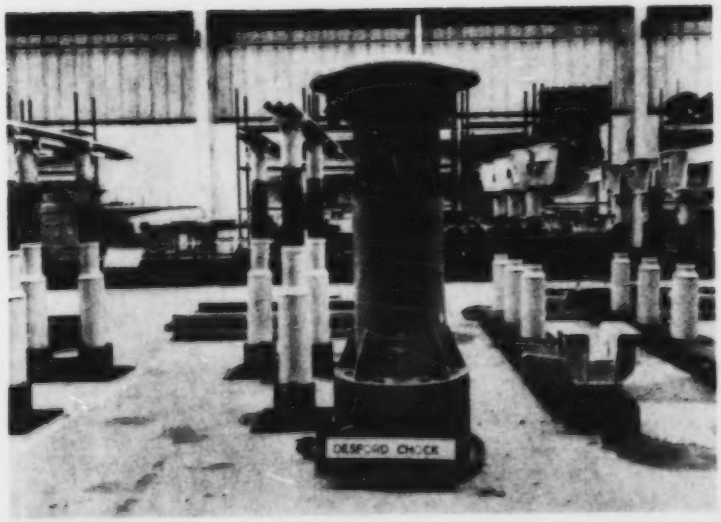

Figure 23. Desford Hydraulic Chock

Figure 24. Dobson "Double Two" Powered Chock

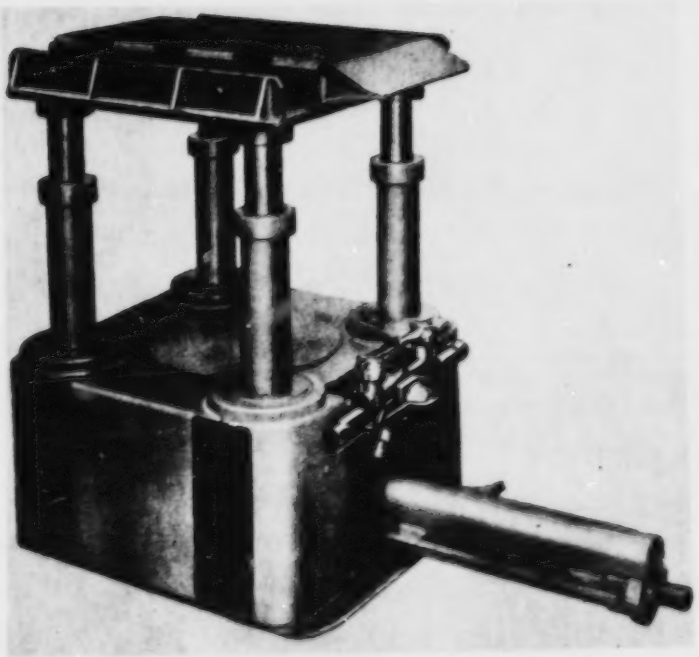

Figure 25. Seaman Powered Chock

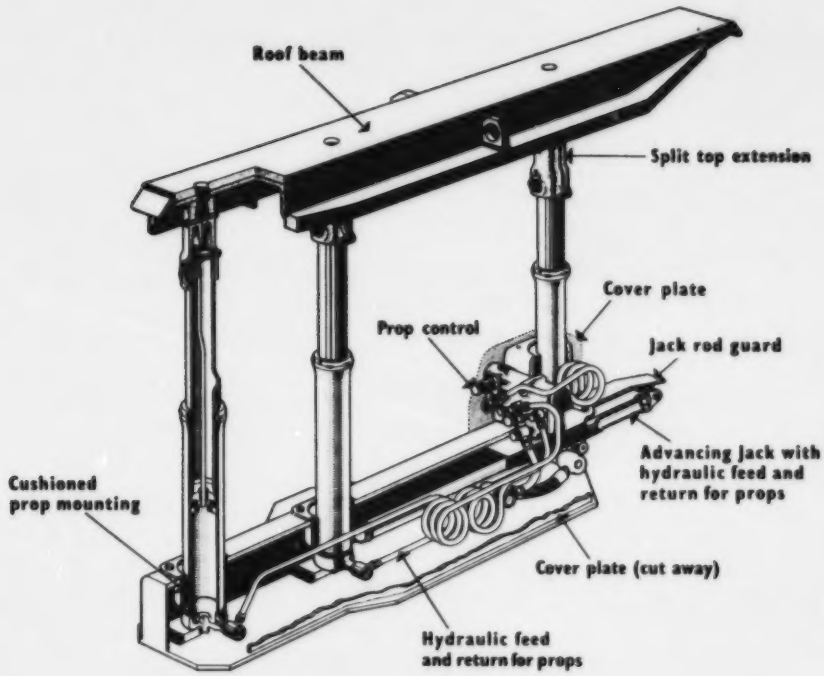

Figure 26. Dowty Roofmaster Powered Chock

Figure 27. Dowty Roofmasters on Coal Face

OPERATING CONDITIONS AND PRACTICES IN COLLIERIES VISITED

Manor Powis Colliery
Alloa Area, Scottish Division, National Coal Board

The Manor Powis colliery is located in the Fife coal field, near Cambus, Clackmannanshire. The principal object of the visit to this mine was to inspect an Anderton Shearer-Loader operating on a 600-foot longwall extraction face.

The seams being worked in the Alloa Area belong to the Limestone Coal Group, which includes the stratigraphically deeper coal seams of Scotland. In the colliery visited, only one seam, the Hirst, was being mined. This seam averages six feet thick but, because of the poorer quality of coal next to the floor rock, about eighteen inches of bottom coal were being left unmined, thus reducing the extraction height to around four and one-half feet. The coal is a slightly coking, high volatile bituminous, with an ash content, in situ, of between 11 and 12 percent. As observed in the coal face, the Hirst seam had a strong structure with well developed stratification and cleavage planes. The immediate roof rock was shale, overlain at a height of about six feet by thinly-bedded limestone. The immediate floor strata were reasonably competent shales.

The main mine entrance was a rock slope, dipping at 22 percent and approximately 2300 feet long. Double-drum slope haulage was employed, using mine cars of two-ton capacity. Underground, the coal was conveyed from the production faces to the car loading point by gateway and trunk belt conveyors. The daily output of approximately

1200 tons of raw coal was being obtained from two shearer-loader faces, one of which was double-shifted.

The longwalls in Manor Powis colliery were being operated as single unit, advancing faces, each approximately 600 feet long, and with substantial pillars of coal left between consecutive faces. There appeared to be some doubt as to whether or not these wide separating pillars would be extracted at some later time.

Physical Conditions and Mining Practices

The extraction face examined during this visit was No. 2 Right Longwall, in the Hirst seam. As already indicated, the length of face was approximately 600 feet, and the extraction height averaged 4-1/2 feet. The depth of cover was about 500 feet. The face supports were three lines of Dobson hydraulic props, spaced on 3-1/2 foot centres. These props were fitted with crown heads that allowed the roof bars to be moved forward without releasing the prop. Additional face supports were provided by prefabricated steel chocks at the waste edge. The wastes were partially packed with 12-foot-wide midwalls spaced on 50-foot centres. In general, the face conditions were satisfactory.

The mechanical mining unit was an Anderton Shearer-Loader, fitted with a cutting drum of 54-inch diameter and a face width of 20 inches. The machine was mounted on the 24-inch-wide face conveyor, and travels along the face by winching itself along a tautly-stretched steel cable. The machine cuts in one direction only and, during each cutting run along the face, it removes and loads a web of coal nearly

20 inches deep and 4-1/2 feet high. The spillage is scooped up and loaded by a plough attachment during the return run of the machine back to its starting point. The machine cuts and loads around 530 feet of the total wall length of 600 feet. The remaining 70 feet are taken up by the stable holes at each end of the longwall face. The coal in these stable holes is undercut, shot down with explosives, and hand-loaded into the face conveyor. The full seam height of six feet is mined in the stable holes.

The shearer-loader was taking 3 cuts per shift, or 6 per day, thus advancing the wall face by about 9 feet daily. The average daily output, during four recent months, was 850 tons. The face productivity, during this same period, was reported to be from 10.7 to 12.2 long tons per man shift.

In summary, a good performance was being achieved with the Anderton Shearer-Loader. The depth of cover was substantially less than in the undersea mines of Nova Scotia, but the strength properties of the coal and immediate roof rock appeared to be reasonably similar. The floor rock appeared to be harder than in Nova Scotia, but it should be realized that the bulk of the face supports at Manor Powis rested on the bottom 18 inches of the coal seam. The working force on the wall face appeared to have their tasks well in hand, and the impression was that of a smoothly co-ordinated operation.

Bickershaw Colliery
No. 2 Area, North Western Division, National Coal Board

Bickershaw colliery is situated about five miles from Wigan. The visit to this mine was made principally to inspect an Anderton Shearer-Loader, working on a longwall face around 850 feet in length.

The coal field, which has been extensively worked since the early part of the nineteenth century, has been heavily faulted. As a result of substantial dislocations in the coal measures, Bickershaw colliery exists as two distinct operating units, in each of which subsidiary faulting controls the placement and continuity of individual extraction faces.

The main entrance was an 18-foot-diameter shaft, approximately 2300 feet deep, in which the coal was wound to surface in 10-ton capacity skips. From the foot of the shaft, a cross-measures tunnel had been driven to intersect the coal seams, and it now serves as the main haulage road to the pit bottom. The current daily production averages 2900 long tons.

Coal production was being obtained from the Peacock, Five Quarters, and Pemberton Five Feet seams and, in addition to these three coal beds, two others, the Rams and the Crombouke seams, were being developed for production. The section of the colliery inspected during this visit was located in the Peacock seam,which averages about six feet in thickness. The coal in this seam is a high volatile bituminous, of good coking quality and an ash content, in situ, of about twelve percent.

From the coal-producing faces underground, the coal was transported laterally on 36-inch-wide conveyors to the foot of a rock tunnel inclined at 1 in 3.4. A plate conveyor in this incline raised the coal to a car loading station in the main cross-measures tunnel. From this point, the mine cars were taken by an endless rope haulage to the coal winding shaft.

Physical Conditions and Mining Practices

The production face inspected was No. 9 East longwall in the Peacock seam. This was a single unit, advancing longwall, about 850 feet long, bordered on one side by a totally extracted area, and on the other side by solid coal. The gradient of the seam was quite low. No. 9 East was being worked beneath a totally extracted area in the Trencherbone seam, which lay 50 feet stratigraphically above. The depth of the workings inspected was about 2100 feet.

As indicated, the Peacock seam averages six feet in thickness but, in order to control the roof, about twelve inches of roof coal were being left up, thus reducing the working height along the extraction face to approximately five feet. The coal had a firm structure, and a well developed cleat. It tended to part readily at the artificial roof beneath the twelve inches of roof coal. The roof strata, where exposed in the gobs, appeared to be competent shales but it is possible that these roof rocks have been weakened by the earlier working in the overlying Trencherbone seam. The immediate floor was about two inches of fireclay, underlain by shale.

The face supports were 20-ton, Dowty hydraulic props and

articulated steel roof bars. The extracted area was partially packed with stone walls about fifteen feet wide.

The mechanical mining unit employed was an 80 H.P. Anderton Shearer-Loader, mechanically coupled to a 50 H.P. longwall cutter. Both machines were mounted on the armoured face conveyor, and travelled along the wall as a single unit. The motive power for travelling was provided by the shearer-loader, which winched itself along an anchored steel cable and pushed the undercutter before it. The combined unit cut and loaded in one direction only, and on the return run a plough attachment scooped up and loaded the spillage left behind during the cutting run. During the return run, the armoured face conveyor was pushed toward the new coal face with Gullick Mark III hydraulic rams, which were spaced at 20-foot intervals along the conveyor. The cutting drum of the shearer-loader on No. 9 Longwall was 44 inches in diameter and 30 inches wide across the face. The thickness of coal web taken by the machine during each trip along the face was therefore about 30 inches. The attached longwall undercutter had a jib 30 inches long, and was so positioned that it made its horizontal cut ten feet ahead of the shearer drum. The cut was made fifteen inches above the bottom of the coal seam. This reduced the load on the shearer, and improved the size of the coal obtained. It was observed that the coal began to part quite readily from the "made" roof in the 10-foot interval between the cutting jib and shearer drum. In normal operation, this mechanical mining unit takes three cuts off the face in 24 hours on the basis of two loading shifts per day. The daily advance of the face was approximately 7 feet. The records for August, 1960, indicate that the average daily production from this face was 1136 long tons. The face productivity was reported as being 11.22 long

tons per man shift employed on No.9 East longwall.

Of the total length of 850 feet, about 750 feet of the extraction face were mined with the shearer-loader, and the remaining 100 feet were taken up by the stable holes at either end of the longwall. The coal in these two stable holes was shot from the solid with pulsed-infused shot firing and hand-loaded into the face conveyor.

Moorgreen Colliery

No. 5 Area, East Midland Division, National Coal Board

Moorgreen colliery is situated about eight miles northwest of Nottingham, on the eastern edge of the Nottinghamshire-Derbyshire coal field. Of interest in this mine was an A. B. Longwall Trepanner, operating on a wall face approximately 840 feet long.

Four seams, the Waterloo, Piper, Low Main, and Silkstone, are being exploited at Moorgreen, and the average daily output of raw coal is about 6600 tons. Of this total, approximately 3600 tons are hoisted in a skip winding shaft, and about 3000 tons are brought to the surface on a cable belt conveyor. This latter operated in a 2000-foot-long stone drift, inclined at 1 in 3. After being cleaned in the wash plant, the 6600-ton daily output of raw coal is reduced to about 5000 tons of saleable coal.

The production face examined during this visit was No. 10 panel (longwall) in the Waterloo seam. In the total working height of approximately 4-1/2 feet, about 3 feet 9 inches are clean coal, and the rest is a soft grey shale which occurs principally as a centre and a

bottom band in the seam. The floor is a hard shale, and although the roof rock appeared to be softer, good roof conditions were being maintained along the wall face. The coal is a high volatile, weakly coking bituminous, containing about 7.7 percent ash. As examined on the coal face it appeared to have a strong structure, with well developed cleavage planes. The depth of cover over the workings was about 750 feet.

The daily output from the Waterloo seam, of approximately 3000 tons of raw coal (2100 tons saleable), was being obtained from three A. B. Trepanners and one Mawco Cutter-Loader.

Physical Conditions and Mining Practices

No. 10 longwall in the Waterloo seam was an advancing extraction face, about 840 feet long and dipping at 1 in 15. As indicated, the depth of the workings was approximately 750 feet. On the 840-foot face, about 750 feet are mined with a 70 hp, A. B. Longwall Trepanner. The balance of the wall length was made up of a 48-foot-long stable hole at the main gate roadway, and a 42-foot-long stable hole at the supply gate road. In these stable holes the seam was undercut with a longwall-type undercutting machine and, after blasting, the coal was hand loaded into the face conveyor. A total of 14 men was employed in these stable holes on two shifts per day. The total force employed daily on the wall face was 49.

As already indicated, the working height along the face was approximately 4-1/2 feet. Roof support in the stable holes was provided by Dowty hydraulic props, with articulated steel roof bars. The rest of

the face, about 750 feet in length, was supported on Dowty Roofmaster hydraulic supports. These units were spaced about 2-1/2 feet apart in a line parallel with the coal face, and were kept moved ahead so that the distance between the front prop of the unit and the coal face never exceeded six feet. The roof in this intervening six feet or less was supported by the cantilevered top bar of the unit. Another function of the Roofmaster supports was to push the armoured conveyor to the coal face after each passage of the Trepanner.

The A. B. Trepanner is a double-ended mining machine, capable of cutting and loading in both directions along a coal face without turning the machine at the end of the longwall face. The machine is floor mounted, that is, it travels along the wall in a path between the armoured conveyor and the coal face, and moves by winching itself along a tautly-stretched chain that extends parallel with the coal face and is securely fastened at each end of the longwall. The coal cutting mechanism is a revolving trepanner head that cuts out a core of coal, about 2 feet in diameter, as the machine moves along the face. The bulk of the coal thus removed falls or is deflected into the face conveyor. To square up the roof, by removing the arc-shaped webs of coal left by the trepanner head, a horizontally revolving roof-cutting disc is mounted on a turret above the machine. The height of this turret jib is adjustable between 2 feet 9 inches and 4 feet 6 inches. A vertical, side-shearing jib has also been incorporated in the machine, to square up the vertical side of the coal face. This jib is also adjustable vertically up to a height of 4-1/2 feet. In order to free the coal, and assist the trepanning action, a third cutting jib has been mounted

at the base of the machine and its function is to put a pre-cut at the bottom of the coal seam. This pre-cut assists the Trepanner during the extraction of the next "lift" of coal. The pre-cutting jib is adjustable to give a depth of cut varying from 1 foot 3 inches to 2 feet 9 inches.

Records supplied by the mine management indicated that production of raw coal on this face was of the order of 700 tons per day, and that the face productivity was around 13 long tons per man shift employed. It would also appear that 2 cuts per shift, or 4 cuts per day, was about maximum performance to date. The productivity for the whole mine was reported to be around 2-1/2 long tons per man shift.

Rawdon Colliery

No. 7 Area, East Midlands Division, National Coal Board

Rawdon colliery is situated near Nottingham in the South Derbyshire coal field. The coal measures have been faulted, but despite this the gradients are generally very low. The operation examined in this mine was a Dosco Miner, operating on a retreating longwall face, at a depth of cover of approximately 1100 feet.

Mining operations in Rawdon colliery are proceeding in three seams: the Stockings, of 8 feet total thickness; the Woodfield, about 5-1/2 feet thick; and the Little Woodfield, of 4 feet thickness. To assist in roof control, the practice in the Stockings and Woodfield seams is to leave up from 6 inches to 18 inches of roof coal. The mine output of raw coal is approximately 2700 tons per day, which is washed, to give a daily saleable output of about 2500 tons. About one-third of

the output is obtained with Dosco Miners and most of the balance from hand-loaded longwalls.

The main mine entrance is a 1000-foot-deep circular shaft, and a modified form of skip hoisting is employed. With this method, the coal is loaded from a storage pocket at the shaft bottom into special containers of 4-ton capacity. These containers are then hoisted to surface in special cages. The underground lateral haulage is entirely by belt, with subsidiary belts of 36-inch width in the gateroads, and 42-inch-wide belts in the trunk roads. These latter discharge into the shaft storage pocket of 100 tons capacity.

No rock is hoisted to surface, for all rock is crushed underground and pneumatically stowed in the Stockings seam.

The mechanized operation observed during this visit was in the Stockings seam. The coal is a high volatile, weakly-coking bituminous, with very few dirt bands, and an ash content of between 6 and 7 percent. The total thickness is approximately 8 feet but, to assist in roof control, only 6-1/2 feet are mined, leaving about 1-1/2 feet of coal on the roof. The immediate floor and roof rocks are grey shales.

Physical Conditions and Mining Practices

The extraction face examined during this visit was a 600-foot long retreating longwall. The gradients along the face, and in the direction of face advance, were almost flat. Original development work in the roadways had been carried out with a 3 JCM Joy Continuous Miner.

As observed in the face, the coal appeared to be as firm as

those of eastern Canada, but cleavage was not as well developed.

The Dosco Miner employed on this face was making one cut along the face per 24 hours, for a daily wall advance of five feet. In this it resembled its Canadian application. However, a very interesting modification in its use has been made in this part of the Derbyshire coal field, in that the seam is always pre-cut ahead of the Dosco Miner in order to reduce the stresses imposed on the machine, and also for the purpose of increasing the size of the coal produced. The Rawdon management considers that pre-cutting of the seam, and the use of larger electric motors, have made the Dosco Miner virtually trouble-free.

The daily output of the Dosco Miner on this wall face was around 620 tons on the basis of one loading shift per day. Undoubtedly, one disadvantage of the Dosco Miner, when compared with the Shearer, Trepanner or Slicer-Loader, is that it is presently limited to one cut per day, which advances the wall about five feet, whereas these other machines can take a number of shallower cuts, that advance the wall up to twice this distance in the same time. As a result, these latter units are producing greater tonnages of coal per 24 hours, and from thinner seams. If the Dosco Miner could be turned around at the end of a cutting run along the face, so that it could cut back in the return direction, it would undoubtedly produce a much greater tonnage of coal in 24 hours than the other longwall mining machines.

Of considerable interest on this wall face was the very substantial, single-unit hydraulic roof supports. This was the Desford Hydraulic Chock, which, from its physical dimensions and simplicity of

design, appears to be a better unit than most other roof supports for withstanding the rigorous conditions experienced underground. The unit is available in 50-ton and 100-ton capacities, and the hydraulic medium is water with a two percent admixture of soluble oil.

The productivity from Dosco Miners at Rawdon mine was reported to be about 12 tons per man-shift employed on the longwall face. The productivity for the whole mine was reported as approximately 2.2 long tons per man-shift.

Whitwell Colliery
No. 1 Area, East Midlands Division, National Coal Board

Whitwell Colliery is located about 35 miles north of the city of Leicester. Of chief interest at this mine was a Mavco Cutter-Loader operating on 570-foot longwall extraction face.

One seam, the High Hazel, was being worked in this colliery, with a thickness of 3 feet 11 inches. Because of a weak shale roof, about 10 inches of roof coal were being left up and, consequently, the mining height was in the order of 3 feet. The immediate floor stratum was a fireclay.

The main mine entrance was a 900-foot shaft, employing skip winding, and all coal was being delivered to an underground shaft pocket by trunk belts. The total daily production of raw coal amounted to about 3800 tons which, when washed, produced a saleable tonnage of about 3000 tons.

Production was being obtained from six longwall faces, four of which were equipped with A. B. Trepanners, one with a Mawco Cutter-Loader, and one was hand loaded. The depth of the workings was about 1300 feet. The gradients were gentle and almost flat.

It was common practice in this colliery to leave a 120-foot-wide ribbon pillar between successive longwall faces. The objects were to reduce deformation of the roadways leading in to the longwalls, and to improve roof control along the extraction faces. However, a considerable amount of bottom heaving was noticeable in a supply roadway running alongside a ribbon pillar, which may have been due to the roadway's being constructed tight against the coal.

Physical Conditions and Mining Practices

The extraction face inspected was No. 33 longwall in the High Hazel seam. This production face was approximately 570 feet long, and the gradient along the face and in the direction of advance was almost flat. As already indicated, the thickness of seam extracted was only 3 feet because of the necessity of leaving up to 10 inches of roof coal to support a fragile shale roof. The coal appeared to have a firm structure, and a well developed cleat. Roof support along the face was provided with 120-ton-capacity Seimen-Gullick, self-advancing hydraulic chocks. These chocks had 5 hydraulic legs instead of the usual 4, the fifth leg being added at the specific request of Whitwell colliery management. The extra leg is set in the chock in advance of the other four. A single line of these supports was being used and, because of the weak roof and floor strata, the units were spaced not more than a

foot apart. Total caving was employed. The close spacing of supports, and the 3-foot working height, made for congested operating conditions. Despite this, a daily production (two shifts) of about 600 long tons was being achieved.

The Mawco Cutter-Loader is a conveyor-mounted unit that cuts and loads in one direction. On its return flight along the face, an attached plough loads any spillage left behind during the cutting run. Haulage of the machine along the extraction face is effected by built-in winching drums that act on a tautly-stretched haulage chain. Average speed when cutting was about 4 feet per minute. In action, the Mawco Cutter-Loader cuts a rectangular-shaped section out of the coal seam as it proceeds along the wall, to a depth of 27 inches and a height of 36 inches (full working height). This cutting action is effected by the travel of a modified cutter chain and picks around a rectangular-shaped guide frame. The large blocks of coal thus produced, pass through the guide frame and are deflected into the face conveyor, along with the fine coal produced by the cutter chain. Unfortunately, these large blocks are difficult to handle, especially in low seams, and consequently a breaker bar must be installed on the machine to reduce them in size.

From 5 to 6 cuts were being taken per day on two shifts, thus advancing the wall face by about 12 feet daily. As indicated, the output of raw coal was in the order of 600 tons per day. The output per man-shift employed at the face was reported to be about 11-1/2 long tons.

As observed on this longwall face, the Mawco was digging into

the soft fireclay floor, and the dirt thus produced was very evident in the coal ploughed into the conveyor when the machine was being 'flitted' back. It was also noted that the machine made very little dust during the cutting operation.

Available information indicates that the size of coal produced with the Mawco Cutter-Loader is much coarser than that obtained with, say, the Anderton Shearer, and that it compares quite favorably with hand-got coal.

Maltby Colliery

No. 3 Area, Northeastern Division, National Coal Board

Maltby colliery is located in the South Yorkshire coal field. Of chief interest in this mine was a Huwood Slicer-Loader operating on a 600-foot longwall face at a depth of 2400 feet. The Barnsley seam, which was the only coal bed being exploited in this colliery, varies between 5 and 7 feet in thickness.

The main mine entrance was a 2400-foot-deep circular shaft, equipped with Koepe hoist, and the coal was wound to surface in 12-ton-capacity skips. Underground, the coal was transported from the extraction faces on secondary and trunk belt conveyors, to three main loading points. At these three points, the coal was loaded into 3-ton-capacity mine cars and then hauled by 100-hp battery locomotives to the shaft pocket. The output was approximately 5200 tons of raw coal per day which, after treatment in the wash plant, was reduced to around 4200 tons of saleable coal.

Ninety-two percent of the output was being obtained from power-loaded longwall faces. Six longwalls were in production, five of these being equipped with Huwood Slicer-Loaders, and one with a Meco Moore machine.

Gas drainage was being employed in Maltby colliery and it was reported as being successful in reducing the methane concentration on power-loaded longwalls. The method employed was to drill 2-1/4 inch diameter holes, to a depth of around 150 feet, and inclined from the gateroad over the goaf. The holes were spaced at 75-foot intervals along the gateroad. The gas was being exhausted to surface, through 12-inch diameter pipe, and discharged out to atmosphere. Consideration was being given to utilizing this gas for drying fine coal.

Although the principal geologic feature in this South Yorkshire coalfield is a broad and gentle anticline, there are faults crossing the measures and, apparently also, zones of "washed-out" and unmineable coal. At times, these latter restrict the continuity of longwall faces, and, perhaps partly for the same reason, the working of single faces is quite common. The dip of the coal deposit is almost flat.

Physical Conditions and Mining Practices

The section visited was Number 12 longwall face, which was a single unit, bordered on each side by several hundred feet of unworked coal. The length of the extraction face was approximately 600 feet and, in this section, the Barnsley seam was about 6-1/2 feet thick. Immediately overlying the coal seam were approximately 8 inches of soft shale overlain in turn by a competent shale roof. The 8 inches of immediate roof

rock falls readily during coal extraction. The floor was a moderately hard shale that allowed very little prop penetration. Roof support was provided by three lines of 20-ton Dowty hydraulic props, with strip pack supports in the waste. The coal had a firm structure, and the principal direction of cleavage was at an angle of about 45 degrees with the long-wall face.

The Huwood Slicer-Loader is a modification of the simple coal plough, with an electrically-activated toothed blade that simulates the action of a miner's hand pick. It is conveyor mounted, and is hauled along the face by a steel cable. On the face observed, the Slicer-Loader was taking four cuts per shift off the face, or eight cuts in 24 hours (2 loading shifts). Each cut was about 10 inches deep, and consequently the wall face was being advanced up to 80 inches per day. The daily output of raw coal from this production face was approximately 950 long tons. The productivity was reported to be about 12 long tons per man shift employed at the face.

As already indicated, the coal in the Barnsley seam has a firm structure and it is much too hard to plough without some form of preparation. At Maltby colliery this preparation takes the form of pre-cutting the seam, at mid height, to a depth of 40 inches. The pre-cutting was being done, at the beginning or end of each of the two daily loading shifts, by pushing a longwall coal cutter ahead of the Slicer-Loader. This cutter made the 40-inch-deep centre cut, and was then stabled for the rest of the loading shift in the supply gate stable hole. For the rest of the loading shift, the Slicer-Loader was engaged in taking off four 10-inch-deep slices. The machine is double-ended and is able to

cut and load in both directions without turning around.

As observed on this production face, the Slicer-Loader was mining the coal readily and it was reported that the time required to remove one 10-inch slice was about 45 minutes. The size of coal produced appeared to be quite comparable with that produced on hand-loaded faces.

Ewald Fortszetzung Mine
Ruhr Coal Field, West Germany

The Ewald Fortszetzung mine is located in the Ruhr coal field, about thirty-five miles east of Duisburg. In this area, the coal-bearing formation has been subjected to severe geological deformations and the general synclinal structure has been traversed by numerous faults. On one limb of the syncline the coal seams have gradients up to seventy degrees, whereas on the opposite limb the seams lie at an inclination of approximately ten degrees. Mechanization of the extraction faces was best developed in the flatter parts of the field. The coal is of good coking quality.

Mining operations were being conducted at a depth of approximately 3000 feet, with an average daily output of 5000 metric tons of coal. About 1200 tons per day, or nearly twenty-five percent of the total output, were being obtained from the longwall face examined during this visit.

The main mine entrance was a 3000-foot-deep shaft, equipped with a Koepe hoist and fitted for skip winding. The skips had a carrying

capacity of eight tons of coal. Underground, the coal was transported from the longwall examined by scraper chain and steel plate conveyors to the pocket of an internal shaft. After being skip-hoisted through this shaft it was transported in 1/2-ton and 3-ton capacity mine cars to the main shaft.

The mine production was being obtained from the Gretchen and Anna seams, which lie very close together and are frequently worked as a single deposit. On the production face examined, both seams were being extracted in a single operation and the total working height was about seven feet. However, the intervening stone band was increasing in thickness along the bottom third of the face and, because it had reached a thickness of 18 to 24 inches, it was intended to abandon the lower leaf and continue in the upper bed only. The immediate roof and floor strata were quite competent sandy shales. The coal was very friable, and its slickensided appearance suggested that the seams had been subjected to severe geological thrusting. The gradient of the coal measures was around ten degrees.

Physical Conditions and Mining Practices

The longwall face visited was passing through a particularly difficult portion of the Gretchen and Anna seams at the time, and extra problems of roof control were being experienced. The face was therefore observed under much less than ideal conditions, due not only to increased load on the face supports, but also because of extra gas emission from the coal seam. Because of these adverse working conditions, and particularly because of the extra emission of gas, the officials reported that they were compelled to reduce the rate of face advance, and consequently

the daily output from around 1800 tons per day to approximately 1200 tons.

The mining machine was a coal plough that was pulled along the coal face by a heavy duty chain of the same type as is employed in a Panzer conveyor unit. The unit ploughs or grooves out a two-foot-high section of the lower bed (Anna) immediately above the floor rock, and below the band of stone that intervened between the Gretchen and Anna seams. As it travelled along the 600-foot-long face, it sheared off and loaded the bottom two feet of coal bed into the face conveyor. Concurrently with this action, the intervening stone and upper coal fell readily from the coal face, and most of this also fell directly into the face conveyor. There was a well developed parting, or weakness, at the contact of the coal bed with the roof rock, and this contributed substantially to the ready fall of the upper coal, and therefore to the success of the operation.

Production of coal amounted to around 600 metric tons per shift and, with a two-shift operation, the total production averaged 1200 tons per day from this single extraction face. The total force employed per shift amounted to 21 men, and it is obvious that a very good performance was being achieved. As mentioned above, production from this face had been substantially reduced because of working conditions, and the management reported that, under unimpeded operation, the face normally produced 1800 tons per day with the same working force. The reasons underlying this excellent performance will be commented on later. The productivity per man shift for the whole mine was reported to be 2.05 tons per man shift employed.

The face supports were steel friction props and articulated steel bars. The extracted area to the rear of the face was being solidly packed by pneumatic stowing behind wire mesh retaining walls. Eight-inch-diameter pipe, laid parallel to the face, was being used to convey the crushed rock by compressed air to the stowing points. Further to this, it was observed that pneumatic stowing, unless carefully done, introduces a serious danger of gas ignition because of the friction-induced sparking, of strong intensity, at the pipe end. The stowing was kept to within fifteen feet of the coal face.

To summarize, the use of the plough gave excellent production results under the seam conditions existing in this mine. Essentially, these results are due to the friable nature of the coal, that enables the plough to dig into it readily. The operation is also assisted by the quite competent nature of the immediate roof and floor rocks. In addition, the 7-foot height of seam contributes very substantially to the high production being obtained.

Despite its undoubted success in the Ruhr coal field, it is not considered that the plough type of mechanical mining unit can be successfully employed in the mines of Nova Scotia, primarily because the coal seams in that province are too strong in structure to allow ploughing. It is considered, however, that ploughing might well be applicable to the friable seams of the mountain coal fields of western Canada.

An important advantage regarding the plough is its simplicity of construction and low capital cost. A serious disadvantage is that its use can only be considered where particular seam conditions exist.

Rheinpreussen, Patteberg Schächte Colliery
Ruhr Coal Field, West Germany

The mine is located in the Ruhr coal field, near the village of Moers-Repelen, and about 20 miles east of Duisburg. Of interest in this mine, from the point of view of face mechanization, was the adaptation of the Dosco Miner for driving entries.

The mine is entered by shafts, approximately 1800 feet deep, and the coal is hoisted in skips of 8-ton capacity. The present output of coal is around 8000 metric tons per day. One seam, the Anna, is being worked and, while the average thickness of this coal bed varies throughout the mine, it was from 7 to 8 feet thick in the workings examined during this visit. The types of mechanical mining units employed include the coal plough and the Dosco Miner. There were three of the latter currently in use. According to the management, the Dosco Miner is being employed wherever the coal is of sufficient thickness, for it is their belief that face supports can be installed more promptly than when using the plough. Under the poor roof conditions common in this mine, the management believes that better roof control can be achieved when using the Dosco Miner.

In common with the other mine observed in the Ruhr coal field, the coal measures tributary to the Rheinpreuben colliery have been subjected to considerable folding and faulting.

Physical Conditions and Mining Practices

The extraction or development face examined was a single-entry roadway, approximately 15 feet wide and carried to a full height of the

Anna seam, or about 8 feet. The dip was quite low and could almost be considered as being flat. The roadway was being driven to develop and prepare for mining a block of coal bordering one of the major faults traversing the coal measures.

The coal seam contained four prominent rock bands, totalling about 24 inches in thickness. This rock was a soft shale, interspersed with thin layers of coal. The immediate roof rock was a weak grey shale, that broke readily at the coal face and required the installation of supports as soon as possible following coal extraction. The floor rock appeared to be of the same weak material, and bottom heaving was noticeable along this development roadway. The weak condition of the rock strata in this location might be attributed to the same geological forces that produced the adjacent faulting. It was observed that the coal parted reasonably well from the roof rock following extraction of the lower part of the seam. The coal was friable, with well developed cleavage and bright lustre. In quality, it is an excellent coking coal.

A standard Dosco Miner has been equipped with two shearer drums, that increase the width of the cutting jib from 5 feet to 10 feet. A further modification was that the Bretby chain was being employed, which allows driving of a front sprocket shaft to the shearer drums, and also carries the picks for the cutting action. The 100 per-cent increase in the width of the cutting jib has, as may be expected, very considerably increased the strains imposed on the machine, and it was learned during the visit that breakdowns were of serious proportions. The operators were much concerned and were actively working on the elimination of failure causes. Their interest in pursuing this major

modification of the Dosco Miner was, as they reported, the result of a general policy to standardize on as few machine types as possible. Thus, they wished to employ the Dosco Miner in development work as well as on longwall faces.

In current practice, they have decreased the load on the machine by taking a shorter "sump", and by not cutting much beyond the mid-height of the coal seam. The softness of the coal and included rock bands was a factor in their favor in reducing shock loads on the machine. In harder coals, it is very doubtful whether the unit could stand up to the loads associated with the use of a 10-foot wide cutting jib.

In performance, a total crew of 23 men, spread over three operating shifts per day, had advanced the level entry as much as 75 feet per day. This included temporary and permanent timbering, and advancing of the conveyor, as well as the loading operation. Because of the poor roof conditions, and the restricted working space in this roadway, the erection of roof supports was a delaying operation. In practice, temporary props were being placed under the steel roof booms as the machine advanced. The unit had to be stopped whenever from five to six feet of roof were exposed, in order to allow the installation of the initial supports. These supports were hydraulic props under steel roof rails. On the two non-loading shifts, temporary props were replaced by H-section steel legs.

In summary, the use of the Dosco Miner as a roadway development machine cannot be considered as a successful application, and much more experimentation will have to be carried out before the desired goal is in view. As of now, the machine is being subjected to heavy over-

loading, leading to mechanical breakdowns. It must also be appreciated that these difficulties are being encountered when mining a coal seam of much weaker structure than those of eastern Canada.

Mine No. 2, Oignies Group
Houillères de Bassin du Nord et du Pas-de-Calais, France

The Oignies Group of collieries in the northern coal fields of France is situated about 25 miles northwest of the city of Douai. Of principal interest in the Number 2 mine of this group was the use of an Anderton shearer-loader in a seam containing a high proportion of rock inclusions. These inclusions occur as bands of shale in a 5-foot seam of friable coal.

The coal-bearing formation at Oignies has been folded into an anticlinal structure and the geological stresses have also produced a large number of faults that traverse the field and have an important influence on mine planning. The seam being worked in the portion of the mine investigated during the visit was the Beck seam of an average height of 5 feet. The coal is a low volatile bituminous, of approximately 10 percent volatiles, with well developed cleavage, and a weak friable structure. Bands of weak grey shale occur in the coal seam and the aggregate width of these bands totals about 40 percent of the total seam height. The immediate roof stratum is a very thick, massive sandstone that does not fail readily in the extracted areas. The floor is a hard sandy shale.

The mine is entered by a shaft, in which the coal is wound to surface in cars in multi-deck cages. The main underground transportation

is electric trolley locomotives. Lateral haulage in the longwall levels is by rubber conveyor belts.

The depth of the workings is approximately 800 feet. Daily mine production amounts to 3000 tons per day of saleable coal, obtained from 7 ploughs and 3 Anderton shearer-loaders. The shearer-loaders are used wherever the seam is so undulating as to prevent the efficient use of ploughs. Because of the high dirt content, only 42 percent of the coal hoisted becomes saleable coal. The friable nature of the coal results in the production mainly of fine coal and, as a consequence, about a half million tons of briquettes are produced annually. Washery middlings, containing about 40 percent ash, are sold to a locally situated thermal power plant generating electricity.

Physical Conditions and Mining Practices

The production face inspected during the visit was an advancing longwall face, approximately 440 feet long. The depth of cover was about 800 feet. The face was advancing uphill through undulating ground in the Beck seam and, because of these undulations, an Anderton shearer-loader was being employed as the coal producing unit.

The gateway leading to the top end of the longwall face was being top-brushed to a point about 15 feet from the coal face, and 10-foot-diameter steel arches were being installed at this position. The gateroad to the bottom end of the longwall face was supported by steel roof booms and wood props. These roadways passed through steep undulations.

Total caving was being employed, with 20-ton friction props

supporting the roof along the face. It was reported that the massive sandstone bed comprising the immediate roof did not cave as well as desired, and that it was fairly common practice to induce caving with explosives.

The Anderton shearer-loader unit was equipped with a cutter drum 32 inches in diameter and about 28 inches wide. As is the practice with this machine, the unit travelled on special slide rails built into the armoured face conveyor, and cut out the bottom 30 inches or so of the coal seam. Because of the friability of the coal, and a well defined parting between the coal and roof rock, the top coal fell readily behind the machine and the bulk of it was delivered directly into the conveyor. Any fallen coal not loaded during the cutting operation was ploughed into the conveyor when the machine was flitted back to the foot of the wall. In total, an excellent performance was being obtained, particularly in view of the many stone bands in the coal face. From 4 to 5 cuts per day were being obtained on the basis of two loading shifts. The daily output of raw (uncleaned) coal was approximately 800 metric tons which, after cleaning, amounted to about 400 tons of saleable coal. The daily advance of the face was around 10 feet. The stable holes at either end of the face, each about 25 feet long, were being hand-picked and hand-loaded into the conveyor. The force employed in these stable holes amounted to 10 men. The total force employed on the wall was 43 men.

The practice of water infusion was being employed in this wall face, with noticeably good results with respect to the amount of airborne dust during coal loading operations. The infusion holes were about 7-1/2 feet long and spaced at 15-foot intervals along the coal face. The infusing pressure was 2500 psi.

Mine No. 9, Hénin-Liétard Group
Houillères du Bassin du Nord et du Pas-de-Calais, France

The Hénin-Liétard Group of collieries is located about thirty miles from Douai and is neighboring to the Oignies Group already described. The mining area is quite prolific in coal seams, there being twenty in about 1300 feet of strata, but the strata have been deformed by folding and faulting and, in addition, the seams contain a very high proportion of impurities, principally in the form of included rock bands. The seam worked at the production face inspected during this visit was the Cecile seam, which is about 56 inches thick; of this total thickness, nearly 23 inches were stone.

The coal in the Cecile seam was a high volatile bituminous, of good coking quality. Stratification and cleat planes were well developed and structurally the coal appeared to be of low strength. The rock inclusions were beds of weak shales. The immediate roof was a competent sandy shale, that failed in massive blocks in the extracted area. There was a well developed parting between the top of the Cecile seam and the overlying sandy shale, that contributed much to the ease of coal getting. The immediate floor rock appeared to be a yielding shale. The dip at the working face was flat. The depth of the workings was around 1300 feet.

The mine entry was by shafts. The daily output of the mine amounted to about 5500 tons of raw coal which, when it had been processed in the surface wash plant, was reduced to 3500 tons of saleable coal.

A total of ten production faces were in operation, two of these being equipped with Anderton Shearer-Loaders, five with ploughs, and three were hand-filled. The management reported that the overall productivity for the mine was 2 metric tons per man shift.

Physical Conditions and Mining Practices

The production face inspected was an advancing longwall, approximately 330 feet long. Originally it was considerably longer, but because of faults it had been shortened to its present length.

The coal-producing unit was an Anderton Shearer-Loader of standard design, that operated in the approximately 3 feet of coal beneath the major rock band. The depth of cut was around 20 inches. Operating on a two-shift-per-day basis, an average of 5 cuts per day were made, with a coal-rock production of about 750 tons. The daily advance of the wall face was about eight feet. As already indicated, there was a well developed parting or line of weakness between the top of the coal seam and the roof rock, and this aided considerably in coal getting. After surface preparation, the daily output of 750 tons of rock and coal from this wall produced about 450 tons of saleable coal.

Roof supports at the coal face were hydraulic props of twenty-ton capacity and in the extracted area total caving was employed. Roof control was not as good as could be desired, likely due to the massiveness of the roof strata and perhaps also to the yielding nature of the floor rock. The roof was broken over the face supports and at the coal face. The props employed appeared to be too light for the existing conditions.

An experiment was being made on this production face, with a trial installation of the SAHE hydraulic "walking" support. This unit is very much in its development stage. On the basis of a limited examination underground it would appear that the telescopic legs could fail in bending if severe roof conditions developed. The bases of these units appeared to be adequately substantial.

ACTIVITIES INCIDENTAL TO COAL MINING OPERATIONS

In line with the recommendation of the Royal Commission on Coal (1959) that attention should be paid not only to mining operations, as such, but also to incidental activities, some inquiries were made in the fields of coal sampling, coal supplies to electrical generating stations, and labour-management relations. The time available did not allow any thorough study of these complex subjects, but certain broad principles did emerge as a result of discussions with management and labour representatives.

Discussions Regarding Bulk Sampling of Coal

During the visit in the north of France, a meeting was held with M. Terra, in charge of coal preparation units and other surface mechanical equipment for the Oignies Group of collieries. The problem of accurately sampling and analyzing coal in bulk shipments was discussed, and because of his considerable experience with the subject, his comments were requested. M. Terra indicated that the obtaining of identical analytical results from the same bulk shipment by two different groups was a very difficult task, due to human error, and particularly so if different sampling methods were employed. Arising out of such differences between two honestly obtained samples could be disagreement between seller and buyer of coals. M. Terra further indicated that such disagreements could be reduced if the work of sampling and analyzing was carried out by a competent organization, independent of, but acceptable to, both buyer and seller of coals. In France, apparently, this approach is being employed. This solution to the problem of accurately and fairly analyzing coal shipments appears to have much to commend it, and warrants

a more detailed study to determine the value of resorting to it in Canada. In Canada, at the present time, the major coal producers and large consumers operate a number of separate sampling and analytical laboratories, amounting in total to very substantial operating costs. Despite this outlay of money and effort, and an honest desire of these organizations to obtain fair and accurate results, there still arise points of difference. It is possible, therefore, that a single analytical organization, of recognized professional standing, could conduct the necessary sampling and analysis with greater harmony among all concerned. Further to this, it is conceivable that a major producer might wish to retain some private laboratory services for operational control of coal washing plants, and for determining the quality of coal seams, while a large coal buyer would wish to have analytical facilities, especially if it is necessary to blend coals.

Coal-Fired Electrical Generating Stations

The growth of coal-fired electrical generating stations in Britain is illustrated in Figure 28, which shows the location and names of stations that are now under construction or were completed during the past few years. During 1959 and to date in 1960, six new coal-fired stations were installed.

Practically all of the electrical generating stations in the United Kingdom use coal and, in total, they buy more coal from the National Coal Board than any other class of customer. During the year ending March 31, 1960, these power stations consumed 43.4 million tons, and it is estimated that this annual consumption will be increased by eight to ten million tons by 1965. Regarding the cost per ton of coal as

LOCATION OF POWER STATIONS
RECENTLY COMPLETED OR
UNDER CONSTRUCTION
UNITED KINGDOM
KINCARDINE
BLYTH
THORPE MARSH
HIGH MARNHAM
STAYTHORPE A
CASTLE DONINGTON
DRAKELOW
HAMS HALL
USKMOUTH

Figure 28

delivered to the power stations, it is reported that this fell from £3.19.5 in 1958-1959, to £3.15.1 in 1960. The reason advanced for this decrease was the increased generation by power stations within the coal-producing areas, with consequent shorter freight hauls and lower transportation costs.

Following the visit to Manor Powis colliery, a call was made at the nearby Kincardine power station, of the South of Scotland Electricity Board. This plant takes the output from Manor Powis and other Fife collieries under a contract that extends for the next 15 years. The generating capacity is being increased, and it was reported that the coal demand at this plant would grow to around 7000 to 8000 tons per day. Of special interest is the fact that this generating station was designed to burn the type of coal produced locally, and undoubtedly this decision will do much to stabilize the coal industry in the Fife coal field. As delivered, the Fife coal contains around 16 percent ash, and approximately 16 to 17 percent moisture. The calorific value is around 9000 B.T.U.'s per pound. Following delivery to this Scottish power plant, the coal is crushed to 75 percent minus 200 mesh, then dried to reduce the water content.

This electrical generating station is an excellent example of what can be done to stabilize local economy through concerted action of thermal plant operators and the coal-producing industry. Admittedly, it may be considerably easier to achieve such co-ordination in nationalized industries coming under the same Ministry of Power.

Labour-Management Relations

Almost all of the discussions related to labour-management relations took place in the United Kingdom. In these discussions it was possible to learn the structure of the organizations set up to facilitate labour-management consultation, but quite difficult, in the short time available, to determine how successfully these organizations were functioning.

In the United Kingdom, the principal union in the coal mining industry is the National Union of Mine Workers. In addition, there are the National Association of Colliery Overmen, Deputies and Shotfirers, and a third union for the clerical staff. It would appear that, insofar as wage negotiations are concerned, the level of wages is established primarily by negotiations between the National Union of Mine Workers and the National Coal Board, and that the other two unions then seek corresponding adjustments for their members.

Provision for consultation between management and labour in the United Kingdom was provided for in the Coal Industry Nationalisation Act of 1946. As implemented by agreement between management and the several unions, a consultative committee was set up at each colliery to deal with practically all social problems, particularly work organization, welfare arrangements, and accident prevention. In this mine committee the colliery manager acts as chairman, and is assisted by thirteen members, four of whom represent management and nine represent the unions. The nine union members include: the area agent of the National Union of Mine Workers, the colliery lodge secretary, one deputy elected by secret ballot, and six representatives of the various categories of workers who

have also been elected by secret ballot. In addition to the above arrangement at the individual mines there is joint consultation on the area, divisional and national levels, through councils which are comprised of representatives from the National Coal Board and the several unions. These divisional and national councils have authority to deal with a broad range of subjects, including production, closing of mines, research work, and problems of health and safety.

As already indicated, it is not easy to judge how efficiently this consultative machinery is functioning. Direct questioning of union representatives in several coal fields brought forth replies that were, on the whole, in favour of the results being obtained. Similar questions, put to managements, indicated that the committees were respected and found useful, and not regarded as empty ceremonies. Despite these reactions, it is difficult to overlook the substantial amount of work stoppage and absenteeism that occurs in the British coal fields, as these occurrences are usually indicative of breakdowns in industrial relations. On balance, it seems reasonable to conclude that, in an undertaking as vast as the British coal industry, with its many thousands of individuals, and varying working and social conditions, it would be folly to expect perfect accord all the time. There is no doubt that properly functioning consultative committees do serve to reduce industrial strife, and it would appear, on the basis of a limited sampling of managerial and union opinions in the United Kingdom, that definite progress in industrial relations has been made in that country. To view these matters in proper perspective it is useful to recall that the system for labour-management cooperation in Canada is much less developed than it is in the United Kingdom, and that the function of

works committees in Canada is generally limited to airing workers' grievances.

RECOMMENDATIONS

The following recommendations are made with the understanding that the most pressing problems facing the Dominion Coal Company have to do with production costs, an urgency to improve the productivity of the underground operations, a need to reduce the production of, or enlarge the market for, fine-size coal, and the desirability of establishing a more cooperative spirit between labour and management.

Obviously, there are a number of other important factors related to the overall efficiency of coal mining operations, but they are not included in these recommendations as it is considered that the Dominion Coal Company is either dealing with these factors in an efficient manner, or the necessary information on how to do so is readily available to them in technical publications. With regard to the factors that are already being handled efficiently, the important ones are the main haulage systems in shafts, slopes and tunnels, and also the mine ventilating systems. With regard to the factors on which information is already available and which, undoubtedly, the Dominion Coal Company officials have already carefully considered, the important one is coal preparation. For these reasons it is considered that main haulage systems, ventilation, and coal preparation have no useful place in the following recommendations, particularly since improved practices were not observed in European coal fields.

It should be added that, insofar as overall productivity is concerned, the mines of the Dominion Coal Company are superior to European collieries. Nevertheless it is useful to consider the newer mining methods adopted in Europe, in the hope that these methods will supply ideas for improving the competitive position of the Dominion Coal Company in Canadian fuel markets.

1. With the object of concentrating coal production, consideration should be given to the use of longer extraction faces than the four-hundred and five-hundred-foot lengths now employed by the Dominion Coal Company. In Europe, face lengths of six hundred feet are common and lengths of up to one thousand feet are in fairly wide use. The longer length of extraction face lends itself to a more continuous operation of mechanical mining machines. The delays and costs associated with stable hole and level brushing operations are reduced in effect as an extraction face is lengthened.

2. Consideration should be given to the introduction of single extraction faces, for the purpose of preventing delays on one face from affecting the operations of adjoining faces. A possible additional benefit will be a reduction in roadway construction and maintenance costs.

3. It is recommended that the Dominion Coal Company continue its current efforts to establish a longwall retreating system for mechanically-mined extraction faces. It is considered that this system offers an effective way of substantially reducing

the production delays inherent to level brushing operations, and also those associated with stable hole construction. It is further considered that the longwall retreating system offers the best opportunity for making important increases in the speed of face advance. A greater speed of face advance would significantly concentrate production on fewer extraction faces, as already recommended in item 1 above.

4. It is recommended that longer conveyor belts be employed to take the coal from individual production faces to central car-loading points, with the object of improving the flow of coal away from the coal-producing machines and thus increasing their output. A start has been made in this direction by the Dominion Coal Company in Dominion Number 20 Colliery and it is recommended that this practice be extended. It is cautioned that the capital outlay will be large.

5. It is recommended that a larger use be made of individual steel supports on longwall faces, and that tests be made with types of powered face supports. It is cautioned, however, that the powered face supports now available were designed for use in flat or low-pitching seams and it is not likely that any of them can be employed, without modification, on the steeper gradients of the Sydney coal field.

Further to this recommendation regarding face supports, it is considered that powered supports are necessary for any substantial increase in the rate of face advance mentioned in item 3 above.

6. With the object of reducing the make of fine-size coal by machines now in use by the Dominion Coal Company, a study should be made of pre-cutting the seam ahead of the Dosco Miner. This practice was observed in the East Midlands coal field, and resulted in improvement in the +2 inch size coal and a lessening of machine load. The effect of pre-cutting on roof control in the Sydney collieries and on the production of -2 inch coal requires study.

7. With the object of reducing the make of fine-size coal, tests should be conducted in the Sydney collieries with one or more of the mechanical mining machines observed during the European inspections, and which have been proved capable of producing, under European conditions, an acceptably large daily output of coal, with a size consist better than that of the Dosco Miner. A suitable choice for first trials is considered to be the Huwood Slicer-Loader. It is common practice in Britain to pre-cut the seam for this machine, and this form of seam conditioning will very likely be required in the Cape Breton coals.

8. With the object of reducing disagreements between producers and consumers regarding the analysis and size consist of bulk shipments of coal, it is recommended that a study be made into the feasibility of establishing a laboratory in the Sydney coal field, whose function should be to sample and analyse coal shipments. The laboratory should be operated by an organization, either private or governmental, that has the

proper technical qualifications and is acceptable to producers and consumers.

9. It is recommended that cocperative studies be encouraged between coal producers and the operators of coal-fired electrical generating plants, and other bulk consumers of coal, with the object of reconciling the coal requirements of these large consumers with the sizes and quality of coal that can be produced in the Sydney coal field.

10. It is recommended that a consultative committee be set up at each mine whose function would be to consider matters related to existing and proposed working methods, working conditions, accident prevention, occupational health questions, and welfare programs. Questions related to wages should be excluded.

11. It is suggested that, each year, the Dominion Coal Company send one, or perhaps two,of its officers to examine coal-mining operations in other countries, with a view to keeping in intimate touch with developments related to extraction, preparation or marketing of coal. It is considered preferable to limit such visits to single individuals or very small groups, and the length of stay in foreign countries need not exceed one month. The results of these inspections, carefully analyzed in terms of local techniques and problems, could be made available to other officers of the Company.

12. In view of the importance of ensuring safety of operations in the mechanized and ever-deepening mines of the Sydney coal field, it is suggested that the Nova Scotia Department of Mines should encourage exchange visits between its coal mines inspectorate staff and the mines inspection agencies of other countries.

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